UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
ANIMAL AND POULTRY HUSBANDRY RESEARCH BRANCH
AND COOPERATING STATES

SIXTEENTH REPORT OF THE

U.S. SHEEP EXPERIMENT STATION and the WESTERN SHEEP BREEDING LABORATORY

DUBOIS, IDAHO
JANUARY 1, 1953 to DECEMBER 31, 1954

THIS REPORT OF RESEARCH PROJECTS NOT YET COMPLETED IS INTENDED FOR THE USE OF ADMINISTRATIVE LEADERS AND WORKERS IN THIS OR RELATED FIELDS OF RESEARCH, AND NOT FOR GENERAL DISTRIBUTION.

SUMMARY

Comparisons of different systems of breeding and the development of more effective methods of selection are emphasized in investigations at this Station and Laboratory. Inbred lines of Rambouillet, Targhee and Columbia sheep have been under formation since 1938-40. These lines were started by grouping related animals or by inbreeding to an outstanding ram. Within-line selection for over-all merit has been followed rather uniformly in all lines. This practice is now being changed toward more diversified ways of developing lines. Comparisons are being made between formation of inbred lines by within-line selection and by recurrent selection of sires from line-cross and top-cross progeny tests. Varying rates of inbreeding, selection for single traits and alternative outcrossing and inbreeding are now being accomplished for some of the lines. Testing of lines by crossing is proceeding as rapidly as ewe numbers will permit. Non-inbred selected groups are being developed in each breed for comparisons with inbred lines and their crosses. In addition, a genetically stabilized group of Rambouillets is being established with selection at random to serve as a control for the selected groups. The poorest inbred lines are being culled to make room for these selected and control groups.

Results from analysis of selection gains at this Station and results from theoretical studies are being combined to provide a basis for recommending improved selection procedures. Procedures such as the rapid turnover of generations and the use of selection indexes appear to increase the gains from selection. Analyses of the various traits of lamb and wool production for heritability, economic importance and inter-relationships are being continued. These analyses will provide information used in improving the accuracy and effectiveness of selection methods.

Studies on physiology of reproduction give promise of providing a basis for more effective selection for high fertility at an early age. Special wool studies are concentrated on estimation of economic importance of various wool traits through their relationships to sorting and processing results. Some work on scourable branding fluids shows that they have useful durability, but these studies are being continued. Cooperative sheep grazing studies with the Forest Service are yielding useful information on the prediction of opening date of grazing and grazing capacity from weather reports.

BIENNIAL REPORT
of the
U. S. Sheep Experiment Station and Western Sheep Breeding Laboratory
Dubois, Idaho
December 31, 1954

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DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING WITH THE WESTERN SHEEP BREEDING LABORATORY

December 31, 1954

ARIZONA:	P. S. Eckert, University of Arizona, Tucson.
CALIFORNIA:	P. F. Sharp, University of California, Berkeley.
COLORADO:	S. S. Wheeler, Colorado State Agricultural College, Fort Collins.
IDAHO:	D. R. Theophilus, University of Idaho, Moscow.
MONTANA:	M. M. Kelso, Montana State College, Bozeman.
NEVADA:	J. R. Bertrand, Nevada Agricultural Experiment Station, University of Nevada, Reno.
NEW MEXICO:	R. A. Nichols, New Mexico State College of Agriculture, State College.
OREGON:	F. E. Price, Oregon State College, Corvallis.
TEXAS:	R. D. Lewis, Agricultural and Mechanical College of Texas, College Station.
UTAH:	R. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	M. T. Buchanan, Washington State College, Pullman.
WYOMING:	H. M. Briggs, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

December 31, 1954

ARIZONA: Ernest B. Stanley, Head, Department of Animal Husbandry, College of Agriculture, University of Arizona, Tucson.

CALIFORNIA: James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.

COLORADO: A. Lamar Esplin, Department of Animal Husbandry, Colorado State College of Agriculture and Mechanic Arts, Fort Collins.

IDAHO: Carl F. Sierk, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.

MONTANA: J. L. Vam Horn, Department of Animal Industry, Montana State College, Bozeman.

NEVADA: J. F. Kidwell, Chairman, Department of Animal Husbandry, University of Nevada, Reno.

NEW MEXICO: Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College.

OREGON: F. F. McKenzie, Chairman, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.

TEXAS: Bruce L. Warwick, Department of Animal Industry, Texas Agricultural Experiment Station, Bluebonnet Farm, McGregor.

UTAH: James A. Bennett, Head, Department of Animal Husbandry, Utah State College, Logan.

WASHINGTON: M. E. Ensminger, Chairman, Department of Animal Husbandry, State College of Washington, Pullman.

WYOMING: M. P. Botkin, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

ROSTER OF PERSONNEL
U. S. SHEEP EXPERIMENT STATION AND THE WESTERN SHEEP BREEDING LABORATORY
Dubois, Idaho
December 31, 1954

Name	Rating	Date Entered on Duty	General Duties
Nordby, Julius E.	Animal Husbandman	March 1, 1938	On leave to FOA, Cairo, Egypt
Terrill, Dr. Clair E.	Animal Husbandman	July 3, 1936	Director
Stoehr, John A .,	Animal Husbandman	Aug. 28, 1928	Operations
Kyle, Dr. Wendell H.	Geneticist	July 7, 1949	Genetics & Statistics
Wiggins, Dr. Earl L.	Animal Geneticist	Oct. 2, 1950	Genetics & Physiology
Wilson, Lowell O.	Marketing Specialist	July 1, 1943	Wool Technologist
Frederiksen, Kenneth R.	Asst. An. Husb.	July 1, 1951	Univ. of Idaho Fiscal Agent & Research
Schaefer, Chester F.	Clerk	June 22, 1936	Head Clerk
Dunn, Harry A.	Clerk	Aug. 22, 1949	Clerk
Hensley, Gladys L.	Statistical Clerk	Aug. 4, 1947	Clerk
Gauchay, Helen D.	Clerk	Feb. 26, 1951	Clerk
Stoehr, Jessie S.	Statistical Clerk	Aug. 25, 1947	Clerk
Vadnais, Ethel R.	Clerk	Dec. 8, 1954	Idaho Clerk
Wagoner, E. Jane	Clerk	Oct. 7, 1954	Idaho Clerk
Jeffery, Lee C.	Foreman of Farm Laborers	June 7, 1924	General Maintenance, Pumps, Equipment
Rasmussen, Henry, Jr.	Farm Laborer	July 1, 1926	Sub-Foreman
Anderson, Daniel	Farm Laborer	Aug. 4, 1947	Shepherd
Bybee, Bert L.	Animal Husb. Aid	Mar. 3, 1949	Equipment Operator and Truck Driver
Grimstad, Peter O.	Livestock Agri. Aid	May 3, 1954	Shepherd
Howard, John H.	Animal Husb. Aid	Oct. 2, 1944	Camp Tender
Ingram, Parley F.	Animal Husb. Aid	Apr. 20, 1947	Shepherd
Phillips, Walter H.	Farm Laborer	Mar. 16, 1935	Truck Driver
Powell, Fred A.	Farm Laborer	May 11, 1935	Farm Laborer
Swink, Albert B.	Animal Husb. Aid	May 31, 1946	Shepherd
Thomas, Walter J.	Livestock Agri. Aid	May 29, 1954	Farm Laborer
Dunn, Helen M.	Laborer	Oct. 1, 1951	Janitress & Cook

OBJECTIVE

Improvement of sheep through breeding is the general objective of this Station and Laboratory. Investigations of systems of breeding and selection are emphasized. Efforts are concentrated on economically important traits that affect lamb and wool production under range conditions. Analyses of genetic and environmental attributes of the important traits and their inter-relationships are used as basic guides in the development of more effective methods of breeding and selection.

The projects presented include all those in effect on December 31, 1954. However the projects are numbered according to the new numbering system adopted March 4, 1955. In this system the Work Project designations, such as APH b1, refer to the Animal and Poultry Husbandry Research Branch of the Agricultural Research Service (APH), the class of livestock (b for sheep) and the type of work (1 for breeding, 2 for feeding, etc.). Each Line Project is assigned a specific number in addition to the Work Project designations.

RESEARCH LINE PROJECTS

APH b 1-5 Investigation of systems of breeding for improvement of range sheep.

Object: To investigate and compare systems of breeding for the improvement of whiteface range sheep of finewool and crossbred types for efficient and profitable lamb and wool production on the western ranges.

A. General plan: Inbred lines of Columbia, Targhee and Rambouillet sheep will be developed in one or more of the following ways and will be tested in crosses insofar as possible:

(1) Mild inbreeding accompanied by within-line selection for overall merit.

(2) Mild inbreeding with recurrent selection of sires from progeny tests.

(3) Rapid inbreeding of large numbers of small lines from outside unrelated sources.

(4) Rapid inbreeding with selection for inbreeding.

(5) Mild inbreeding with random selection.

(6) Mild inbreeding with maximum within-line selection for a specific trait.

(7) Alternative outcrossing and inbreeding.

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B. Non-inbred strains of Columbia, Targhee and Rambouillet sheep will be developed by selection for overall merit as estimated by an index.

C. Genetically stabilized control groups, with artificial selection entirely at random, will be established to serve as a control to lines and strains developed in parts A and B. Initially this will involve a breeding group of 100 Rambouillet ewes.

APH b 1-6 Investigations of traits for use in breeding and selection of range sheep.

Object: To investigate various attributes of traits in sheep to determine the relative importance of these traits in sheep breeding and selection programs and to obtain essential information for the development of efficient breeding and selection procedures for the improvement of these traits.

General Plan: All traits on which data are collected will be included. New traits that have promise of usefulness will be added.

Kinds of information to be obtained for each trait include the following:

(1) Development and improvement of techniques of measurement.
(2) Determination of mean and variability.
(3) Determination of effects of measurable environmental factors.
(4) Estimation of economic importance.
(5) Estimation of heritability, type of gene action and other genetic attributes.
(6) Calculation of repeatability.
(7) Calculation of genetic and phenotypic relationships to other traits.

This information will be used in the development of breeding and selection procedures including the calculation of selection indexes.

APH b 1-7 Studies in physiology of reproduction of range sheep.

Object: To study attributes of normal reproduction in range sheep and factors which affect it. Emphasis will be placed on the identification of environmental factors which have important effects on reproductive performance and on the development of early measures of potential reproductive performance in both sexes to aid in the selection of highly fertile animals.

General Plan: Semen studies will be made on rams before breeding and laboratory techniques of evaluating semen will be studied to improve the predictive value of semen tests. Studies will be made of sexual development of ram lambs, and its relation to subsequent semen production and breeding performance. Age of

puberty in ewe lambs will be studied in relation to later production. Animals with abnormalities of reproduction or reproductive organs will be examined. Investigations will be made of factors affecting reproduction of rams and ewes.

APH b 3-1 Studies of sheep grazing management on spring-fall ranges of the Intermountain Region in cooperation with the Forest Service.

Object: To determine what method of grazing management with sheep will permit the fullest use of spring-fall range and, at the same time, obtain highest possible forage production.

General Plan: These studies will include research on the effect of climate on forage production, the rotation of grazing use of certain ranges, the intensity of grazing use, ways of removing sagebrush and improving spring-fall range by reseeding, and the effects of management methods on the forage and on the sheep.

APH b 3-3 Development of improved sheep branding fluids.

Object: To develop a sheep branding fluid that will remain legible and also scour out of the wool by current mill scouring processes.

General Plan: Tests will be made of the durability, legibility and scourability of various sheep branding fluids including those developed by the U.S.D.A.

APH b 3-4 The response of Targhee sheep to the environment prevailing at the Idaho Agricultural Experiment Station, Moscow, Idaho in cooperation with that Station.

Object:

1. To study the influence of environment in heavy feed-producing areas on wool and lamb production with Targhee sheep.

2. To study the individual rate and efficiency of gains on Targhee sheep.

3. To develop a flock of Targhee sheep with major emphasis on production merit.

General Plan: Targhee sheep will be transferred from Dubois to Moscow, Idaho. Records will be taken on these sheep similar to those taken at Dubois. In addition, records of individual rate and efficiency of gain will be made on selected sheep.

APH b 5-2 Genetics and physiological factors influencing processing qualities of wool.

Object:

1. To determine sorting and processing qualities of Columbia, Targhee and Rambouillet wool produced at Dubois, Idaho.

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2. To obtain information in the usefulness of data on sorting and processing qualities of wool in a breeding and selection program for sheep.

3. To determine the minimum amount and kind of sorting required for satisfactory processing results.

General Plan: Fleeces and groups of fleeces sorted according to commercial practices will be studied with respect to wool characteristics in the sorted classes. Processing and manufacturing studies will be carried on with these wools at Beltsville, Maryland, and where feasible in cooperation with other agencies. Data on sorting and processing qualities will be analysed to determine their usefulness in a breeding and selection program. Processing studies will be carried on with lots of wool from sorted, partially sorted and unsorted fleeces.

PUBLICATIONS

The following papers have been published by the Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station since 1937.(A number of papers that have been listed under "publications" in previous lists have not been published and have been removed from this list. They can be found under the listing of "Papers in Preparation for Publication".) Some publications of other agencies are included of work to which the Laboratory and Station have contributed. A number of contributions have been made to livestock journals and the general press that are not included in this series. They are for the most part adaptations of the regular series but rewritten for the lay reader. Reprints are still available for many of these publications.

1. Measurement of Reproductive Capacity as an Aid in Selection of Rams of High Fertility (A preliminary report). C. E. Terrill, Proc. Amer. Soc. Anim. Prod., 1937, pp. 311-316.

1a. A Comparison of Some Methods used in Determining Percentage Utilization of Grasses. J. F. Pechanec and G. D. Pickford. Jour. Agri. Res. 54(10):753-765, 1937.

2. Artificial Insemination of Ewes. C. E. Terrill and E. M. Gildow, National Wool Grower, 27(12):35, Dec., 1937.

2a. A Weight Estimate Method for the Determination of Range or Pasture Production. J. F. Pechanec and G. D. Pickford. Jour. Amer. Soc. Agron. 29(11):894-904, 1937.

3. Another Experiment on Long Range Paternity in Sheep. C. E. Terrill and E. M. Gildow. Jour. of Heredity, 29(2):77-78, Feb., 1938.

3a. The Influence of Climate and Grazing on Spring-Fall Sheep Range in Southern Idaho. Geo. W. Craddock and C. L. Forsling, U.S.D.A. Tech. Bull. 600, 1938.

4. Artificial Insemination of Ewes with Transported Semen. E. M. Gildow and C. E. Terrill. Jour. Amer. Vet. Med. Assoc. N. S. 46(3):157-159, Sept., 1938.

5. Reproductive Capacity of Rambouillet Ram Lambs as Indicated by Semen Tests. C. E. Terrill, Proc. Amer. Soc. Anim. Prod., 1938, pp. 308-310.

6. A Preliminary Study of the Relation Between Fleece Characteristics of Weanling and Yearling Range Sheep. W. V. Lambert, J. I. Hardy and R. G.Schott, Proc. Amer. Soc. Anim. Prod., 1938, pp. 298-303.

7. Reproduction in Range Sheep. C. E. Terrill and John A. Stoehr, Proc. Amer. Soc. Anim. Prod., 1939, pp. 369-375.

8. Selection of Range Rambouillet Ewes. C. E. Terrill, Proc. Amer. Soc. Anim. Prod., 1939, pp. 333-340.

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9. Comparison of the Accuracy of Two Methods of Estimating Fineness of Wool Fibers. Ralph W. Phillips, R. G.Schott, J. I. Hardy and and H. W.Wolf, Jour. Agri. Res. 60(5):343-350, Mar. 1, 1940.

10. A Summary of Three Year's Work in the Transportation of Ram Semen for Artificial Insemination. Ralph W. Phillips, R. G. Schott, E. M. Gildow and C. E. Terrill. Proceedings of the Second National Meeting of Veterinary Surgeons of Italy, 1940, pp. 231-237.

11. The Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station. Julius E. Nordby, Extension Animal Husbandman, Sept., 1940.

11a. Sagebrush-grass Range Sampling Studies: Size and Structure of Sampling Unit. J. F. Pechanec and G. Stewart, Jour. Amer. Soc. Agron. 32(9):669-682, 1940.

12. Genetics and Range Sheep Improvement. Julius E. Nordby. Scientific Monthly 51:310-320, Oct., 1940.

13. Some Factors Affecting the Progeny Testing of Rams. Ralph W. Phillips, R. G. Schott, W. V. Lambert and G. W. Brier, U.S.D.A. Cir. 580, 17 pp., Oct., 1940.

14. The Application of a Rapid Comparator Method for Determining Fineness and Variability in Wool. Elroy M. Pohle, Proc. Amer. Soc. Anim. Prod., 1940, pp. 161-168.

15. Comparison of Ram Semen Collection Obtained by Three Different Methods for Artificial Insemination. Clair E. Terrill. Proc. Amer. Soc. Anim. Prod., 1940, pp. 201-207.

16. Growth in Corriedale and Rambouillet Sheep under Range Conditions. Ralph W. Phillips, John A. Stoehr and G. W. Brier, Proc. Amer. Soc. Anim. Prod., 1940 pp. 173-181.

17. Sheep Improvement for Range Production. Julius E. Nordby, Idaho Forester 23, 1941, Forestry School, University of Idaho.

18. A Rapid Method for expressing Medullation in Wool. Elroy M. Pohle, A. H. D. No. 41, May 1941, 66 pp. (Processed).

19. Columbia Sheep and Their Place in Range Sheep Production. Damon A. Spencer and John A. Stoehr, A. H. D. No. 42, Oct., 1941, 2 pp. (Processed).

20. Targhee Sheep and Their Place in Range Sheep Production. Damon A. Spencer and John A. Stoehr, A.H.D. No. 43, Oct., 1941, 2 pp. (Processed).

21. Face Covering in Range Sheep. Clair E. Terrill. A.H.D. No. 49, Nov., 1941, 9 pp. (Processed).

21a. Sagebrush-grass Range Sampling Studies: Variability of Native Vegetation and Sampling Error. J. F. Pechanec and G. Stewart, Jour. Amer. Soc. Agron. 33(12):1057-1071, 1941.

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22. Wool Yield Determination in Which Small Samples are Compared with Whole Fleeces. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer, and Glenn W. Brier, A.H.D., No. 50, Jan., 1942, 6 pp. (Processed).

23. Wool Yields in the Small Side-Sample as Related to Individual Whole-Fleece Yields in Four Breed-Groups of Sheep. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Jour. Anim. Sci. 1(2):137-144, May, 1942.

24. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr. Jour. Anim. Sci. 1(3):221-228, Aug., 1942.

25. Relationship between Weanling and Yearling Fleece Characters in Range Sheep. Elroy M. Pohle. Jour. Anim. Sci. 1(3):229-235, Aug., 1942.

26. Staple Length in Relation to Wool Production. Elroy M. Pohle and Henry R. Keller. Jour. Anim. Sci. 2(1):33-21, Feb., 1943.

27. Improving Rambouillet Sheep for Western Ranges. Julius E. Nordby. National Wool Grower 33(3):12-17, Mar., 1943.

28. Staple Length and Its Influence on Shrinkage and Fleece Values. Elroy M. Pohle, and Henry R. Keller, National Wool Grower 33(6): 22-24, June, 1943.

29. Stabilizing Wool and Body Type in White Faced Crossbred Sheep for Western Range Production. Julius E. Nordby. National Wool Grower 33(7):15-17, (8):16-18, July and August, 1943.

30. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, U.S.D.A. Circular 704, August, 1944. Revised March, 1947.

31. Wool Fineness in Eight Sampling Regions on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott. Jour. Anim. Sci. 2(3): 197-208, Aug., 1943.

32. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces, Elroy M. Pohle, H. W. Wolf and Clair E. Terrill. Jour. Anim. Sci. 2(3):181-187, Aug., 1943.

33. Fiber Density and Some Methods of its Measurement in the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle. Jour. Anim. Sci. 2(3):188-196, Aug., 1943.

34. Estimation of Clean-Fleece Weight from Grease-Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle, L. Otis Emik and Lanoy N. Hazel. Jour. Agri. Res. 70(1):1-10, Jan. 1, 1945.

34a. Sagebrush Burning - Good and Bad. J. F. Pechanec and G. Stewart, U.S.D.A. Farmers' Bull. No. 1948, 1944.

35. Clean-Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. Anim. Sci. 3(2):159-165, May, 1944.

36. Shrinkage and Value by Grades for 1943 Range Wool. Elroy M. Pohle and Henry R. Keller. National Wool Grower 34(6):22-23, June, 1944. (Published in other Wool Growers Magazines).

37. Some Factors Affecting the Blood Phosphorus Level of Range Ewes. W. M. Beeson, Clair E. Terrill and D. W. Bolin. Jour. Anim. Sci. 3(2):175-182, May, 1944.

37a. Improving Sagebrush Ranges by Planned Burning. J. F. Pechanec and G. Stewart. Natl. Wool Grower 35(6):13-15, (7):13-15, 1944.

38. The Accuracy of Measurements and Weights of Sheep. Ralph W. Phillips and John A. Stoehr, Jour. Anim. Sci. 4(3):311-316, Aug., 1945.

39. Monthly Changes in Fineness, Variability and Medullation in Hairy Lambs. Elroy M. Pohle, H. R. Keller and L. N. Hazel. Jour. Anim. Sci. 4(1):37-46, Feb., 1945.

40. More Profit in Open Face Ewes. Clair E. Terrill. Montana Wool Grower 18(1):13, 47, Jan., 1944. (Published in other Wool Growers Magazines).

41. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yields. E. M. Pohle, L. N. Hazel and H. R. Keller. Jour. Anim. Sci. 4(2):104-112, May, 1945.

42. Wool Off-sorts, Percentage, Shrink, Value. Elroy M. Pohle and Henry R. Keller, Montana Wool Grower 18(6):7, June, 1944. (Published in Other Wool Growers Magazines).

43. Effectiveness of Selection on Progeny Performance as a Supplement to Earlier Culling in Livestock. G. E. Dickerson and L. N. Hazel. Jour. Agri. Res. 69(12):459-476, Dec. 15, 1944.

44. Looking Forward, The Stabilizing Influence of Research in a Changing Sheep Production Economy. Julius E. Nordby. National Wool Grower 35(6):18-19, 35-36, June, 1945.

45. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. J. E. Nordby, C. E. Terrill, L. N. Hazel and J. A. Stoehr. Anat. Rec. 92(3):235-254, July, 1945.

46. Effects of Some Environmental Factors on Weanling Traits of Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill. Jour. Anim. Sci. 4:331-341, Nov., 1945.

47. Heritability of Weaning Weight and Staple Length in Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill. Jour. Anim. Sci. 4:347-353, November, 1945.

48. Heritability of Type and Condition in Range Rambouillet Lambs as Evaluated by Scoring. L. N. Hazel and Clair E. Terrill. Jour. Anim. Sci. 5:55-61, February, 1946.

49. The Covariance Analysis of Multiple Classification Tables with Unequal Subclass numbers. L. N. Hazel. Biometrics Bulletin 2(2):21-25, April, 1946.

50. Heritability of Face Covering and Neck Folds in Range Rambouillet Lambs as Evaluated by Scoring. Clair E. Terrill and L. N. Hazel. Jour. Anim. Sci. 5(2):170-179, May, 1946.

51. Effects of Some Environmental Factors on Weanling Traits of Range Columbia, Corriedale and Targhee lambs. L. N. Hazel and Clair E. Terrill. Jour. Anim. Sci. 5(3):318-325, August, 1946.

52. Heritability of Weanling Traits in Range Columbia, Corriedale and Targhee Lambs. L. N. Hazel, and Clair E. Terrill. Jour. Anim. Sci. 5(4):371-377, November, 1946.

53. Effects of Some Environmental Factors on Fleece and Body Characteristics of Range Rambouillet Yearling Ewes. L. N. Hazel and Clair E. Terrill. Jour. Anim. Sci. 5(4):382-388, Nov., 1946.

54. Length of Gestation in Range Sheep. Clair E. Terrill and L. N. Hazel. Amer. Jour. Vet. Res. 8(26):66-71, January, 1947.

55. Refining Methods of Using Opal Blue Stain in Evaluating Ram Semen. L. O. Emik and G. M. Sidwell. Jour. Anim. Sci. 6(1):67-71, Feb., 1947.

56. Breed Crosses Used in the Development of Targhee Sheep. Clair E. Terrill. Jour. Anim. Sci. 6(1):83-92, February, 1947.

57. Range Sheep Improvement Through Selection. Clair E. Terrill. National Wool Grower 36(12):17-19, December, 1946.

58. Color on the Legs of Sheep. Its Inheritance in the Columbia and Targhee Breeds. Clair E. Terrill. Jour. Hered. 38(3):89-92, March, 1947.

59. Effects of Some Environmental Factors on Yearling Traits of Columbia and Targhee Ewes. Clair E. Terrill, G. M. Sidwell and L. N. Hazel. Jour. Anim. Sci. 6(2):115-122, May, 1947.

60. It's the Clean Wool in the Fleece that Pays Off. Elroy M. Pohle. National Wool Grower 37(5):19-20, May, 1947.

61. Statistical Treatment of Trichostrongylid Eggs. L. Otis Emik. Biometrics 3(2):89-93, June, 1947.

62. Factors Affecting the Estimation of Concentration of Ram's Semen by the Photoelectrometric Method. L. Otis Emik and George M. Sidwell. Jour. Anim. Sci. 6(4):467-475, November, 1947.

63. Development of Targhee Sheep. Clair E. Terrill and John A. Stoehr. National Wool Grower, 37(11):13-14, Nov., 1947.

64. Tailless Sperm from Rams. L. Otis Emik and George M. Sidwell. Jour. Anim. Sci. 8(1):67-72, Feb., 1949.

65. Gestation Period in Sheep. Clair E. Terrill and John A. Stoehr. Sheep and Goat Raiser 28(6):23, March, 1948. (Published in other Wool Growers Magazines).

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PAPERS IN PREPARATION FOR PUBLICATION

This listing of the papers in preparation for publication has been made for the convenience of the reader. Those papers which have been listed under "Publications", and were merely in preparation, will recur under "Publications" in chronological order as they are published.

Title	Author(s)
Increasing Accuracy of Selecting Rams.	Clair E. Terrill
Selecting Rambouillet Ewes for High Lamb Production.	Clair E. Terrill
The Semen Production of Rams Under Range Conditions.	L. O. Emik and C. E. Terrill
The Effect of Successful Embryo Transplantations on the Progress Expected from Selection.	Wendell H. Kyle
Effectiveness of Selection for Economically Important Traits of Sheep.	Clair E. Terrill
Correlations Between Traits of Range Rambouillet Rams	C. E. Terrill, W. H. Kyle and L. N. Hazel.
Heritabilities and the Relative Accuracies of Individual Committee Scores for some Traits of Sheep.	Wendell H. Kyle
Predicting Live Normal Sperm in Rams from Motility Scores.	L. O. Emik, C. E. Terrill and G. M. Sidwell
Phenotypic and Genetic Correlations Between the Weanling Traits of Range Rambouillet Lambs	L. N. Hazel and C. E. Terrill
Construction and Use of a Selection Index for Range Rambouillet Lambs.	C. E. Terrill and L. N. Hazel
The Effect of Selection on the Incidence and Heritability of Neck Folds in Rambouillet Weanling Lambs.	C. E. Terrill and W. H. Kyle
Heritabilities and Repeatabilities of Fleece and Body Traits in Rambouillet, Targhee and Columbia Sheep Born in 1951.	W. H. Kyle and C. E. Terrill
The Use of Control Flocks in Breeding Experiments with Sheep.	Clair E. Terrill

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Title	Author(s)
Coefficients of Relationship and Inbreeding - The Use of the Numerator Relationship Table.	Clair E. Terrill
Calculation of Selection Indexes.	Clair E. Terrill
Concepts and Interpretations of Path Coefficients.	Wendell H. Kyle
Heritability and Relationship to Other Traits of Carding and Combing Yields of Main Sorts of Individual Targhee Fleeces.	C. E. Terrill, M. E. Hourihan F. E. White and T. D. Watkins, Jr.
Cull Those Dry Ewes	Earl L. Wiggins
Fertility in Range Rams	Earl L. Wiggins
Can Ram Lambs be Used in Breeding?	Earl L. Wiggins
The Collection, Examination and Evaluation of Ram Semen.	Earl L. Wiggins

ABSTRACTS

The following abstracts have been published by the U. S. Sheep Experiment Station and Western Sheep Breeding Laboratory since 1937. In general these are abstracts of work that has been or will be published in the regular series of publications. Abstracts are not reprinted by the publishing journal. However, mimeographed summaries plus data tables are available for some of the titles listed.

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2. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr. Jour. Anim. Sci. 1(1):60-61, Feb., 1942.

3. Fineness of Fiber in Eight Sampling Areas on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott. Jour. Anim. Sci. 1(4):356, Nov., 1942.

4. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces. Elroy M. Pohle, H. W. Wolf and Clair E. Terrill. Jour. Anim. Sci. 1(4):356, Nov., 1942.

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19. The Effects of Environmental and Hereditary Factors on Trichostrongylid Worm Infestation on Sheep. L. Otis Emik and Paul W. Gregory. Jour. Anim. Sci. 6(4):477-478, Nov., 1947.

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21. Predicting Live Normal Sperm in Rams from Motility Scores. L. Otis Emik, Clair E. Terrill and Geo. M. Sidwell. Jour. Anim. Sci. 7(4):511, Nov., 1948.

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BREEDING PLANS 1952-53

A total of 2639 ewes were bred in 1952. Pen breeding of the first band (which included all Rambouillet pens and the Targhee test pens) extended from November 4 to December 5 and range breeding extended from December 12 to January 7. Range breeding here refers to turning Columbia rams into the first band about a week after pen breeding to rebreed the ewes that did not conceive in pen breeding. Offspring from these Columbia rams and Rambouillet ewes are tagged in the "T_1" series and offspring from the Targhee ewes are tagged in the "KlB" series. Columbia and Targhee ewes (except for Test Targhees) were bred from November 18 to December 22. The distribution of ewes by breed and type of mating is shown in the following table:

Breed	No. of ewes bred	Inbred lines No.	%	Breed crosses No.	%	Line crosses No.	%	Selected controls No.	%	Test ewes No.	%	Black* markers No.	%
Rambouillet	1219	726	60			178	15	222	18	80	6	13	1
Targhee	839	559	67	8	1			95	11	166	20	11	1
Columbia	581	344	59			156	27	81	14				
ALL	2639	1629	62	8	-	334	13	398	15	246	9	24	1

*Black marker ewes were not used in the breeding program. This was the last full season that black marker ewes were maintained in the flock. In February, 1954, all black marker ewes were sent to market.

Rambouillet lines

Lines 42 and 43 were culled this year leaving a total of 27 lines of Rambouillets. It was necessary to reduce the number of ewes after culling to avoid increasing the grazing pressure on the summer range. Line 42 was about average in its own merit but carried a recessive gene for black color on the belly and legs. A pedigree analysis of line 42 indicated little chance of eliminating the gene for black color by selection on the basis of pedigree. Line 43 was the poorest line in overall merit and had also given poor results in crosses. In line 28, sire 9115W produced two black lambs in 1950 when mated to his daughters. In the 1951-52 breeding season, two sons of 9115W were tested on their half sisters. Although the tests were incomplete (P=approximately .24) because of low lamb production in 1952, neither ram produced any black offspring. In the fall of 1952, all daughters of 9115W were culled in an attempt to eliminate the recessive gene for black color, although three daughters (lambs) of these ewes were retained by mistake. The remaining 9 head of ewes were mated to the better ram of the two which had been tested. Whether or not the black gene was completely eliminated from the line will not be known for several years. However, to date line 28 has not produced any more black lambs. For the 27 Rambouillet lines the average number of ewes per line was 26.9 as compared with an average of 25.5 ewes per line bred in 1951.

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Rambouillet cross lines

A new series of line crossing was initiated this year. Twenty ewes were taken at random from each of lines 39, 46, 49, 50 and 51. Two ewes from each line were mated at random to each of 2 rams from lines 25, 26, 35, 36 and 40. Thus three ewe lines, 49, 50 and 51, and one sire line, 25, were continued in the crossing tests. This will provide some basis of comparison with previous crosses. All ewes of breeding age produced in the previous series of line crossing were culled to avoid increasing numbers. The balance of the cross line matings were involved in recurrent selection.

Rambouillet selected control group

This group of about 200 ewes, which was initiated in 1947, is maintained with major emphasis on selection for traits of high heritability and high economic importance and with some effort to minimize inbreeding. In past years 4 rams have been used in this control group a second year because their progeny ranked highest in the previous year. Two of these 4 rams ranked above average for progeny born in the second year but none excelled all other rams used. The average index of the progeny of tested sires was very slightly lower than the comparable average of the progeny of all rams in those years. Thus nothing was gained by using progeny tested sires as compared with using the best young rams available. The theoretical studies have confirmed this. Therefore, the breeding plan was modified beginning in 1952. The best 4 yearling rams will be used each year. Their mates will be chosen from the group at random except that, as in the past, sire-dam and half-sib matings will be avoided. Also the use of more than one son from each sire will be avoided.

Rambouillet recurrent selection

Test matings and recurrent selection of sires were continued in lines 20 and 27 and lines 53 and 54, the same as in 1951. Four rams from each line were each mated to five test ewes. These were the only test matings made with Rambouillets. Each ram was also mated to five ewes from the other line, and the merit of the cross line offspring is the primary basis for recurrent selection.

Targhee lines

A total of 559 ewes were mated in 18 inbred lines. This involved an increase of 79 ewes over last year although the proportion of Targhee ewes mated in lines remained the same. The average number of ewes per line was 31.1 as compared with 26.7 in 1951. Only 8 ewes which descended from a Border Leicester ram were backcrossed to a polled Rambouillet ram. The backcross offspring which have Targhee type fleeces (1/2 Blood) will be interbred in line 10T, which was started as a line in 1951-1952.

Targhee selected control group

A total of 95 test ewes were randomized to the 18 rams used in inbred lines. Offspring from these and future matings will be the foundation for a selected control group in which selection will be emphasized and inbreeding will be minimized.

Targhee recurrent selection

Test matings and recurrent selection of sires were continued for lines 16T, 17T and 18T the same as in 1951. Six rams from each line were tested. No other Targhee test matings were made.

Columbia lines

A total of 344 ewes were mated in the 10 inbred lines of Columbias. The average number of ewes per line was 34.4 as compared with 33.1 in 1951.

Columbia cross lines

Cross line matings were continued, the same as in 1951, with 7 of the 10 Columbia lines. Two rams from each of these lines were each mated with 10 to 12 crossline ewes. These ewes were from crosses of 2 to 5 lines made in previous years. In most cases a ram was not mated to crossline ewes descended from his own line. The 3 lines not used in crossing in 1952 were 1, 5 and 7 which had been crossed extensively in previous years.

Columbia selected control group

A total of 81 test ewes were randomized to the 17 rams used in inbred lines. Offspring from these and future matings will be the foundation for a selected control group in which selection will be emphasized and inbreeding will be minimized.

Summary

This year about 62% of the ewes were bred in inbred lines, 15% were bred in or produced offspring for selected control groups, 13% were bred in line crosses and 9% were used for testing rams. This represents slight increases in the proportion of ewes bred in inbred lines and selected control groups and slight decreases in the proportion used for crossing lines and testing sires. There was a decrease in the proportion of Rambouillet ewes (46% of flock as compared with 50% in 1951) and an increase in the proportion of Targhee ewes (32% of flock as compared with 28% in 1951). The proportion of Columbia ewes in the flock (22%) remained the same as in 1951.

BREEDING PLANS 1953-54

A total of 2673 ewes were bred in 1953. Pen breeding of the first band (which included all Rambouillet pens and the Targhee test pens) extended from November 3 to December 3. Range breeding of the first band to Columbia rams extended from December 10 to December 24. Columbia and Targhee ewes (except Targhee test ewes) were pen bred from November 20 to December 23. The distribution of ewes by breed and type of mating is shown in the following table.

Breed	No. of ewes bred	Inbred lines		Breed crosses		Line crosses		Selected controls		Test Ewes		Genetically stabilized controls	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Rambouillet	1267	693	55			156	12	209	16	177	14	32	3
Targhee	852	533	63	6	1	36	4	111	13	166	19		
Columbia	554	312	56			154	28	88	16				
ALL	2673	1538	58	6	-	346	13	408	15	343	13	32	1

Rambouillet lines

In the 27 inbred lines of Rambouillets, the average number of ewes per line was 25.7 as compared with an average of 26.9 ewes per line bred in 1952. In the fall of 1953, several changes were initiated in the methods of developing inbred lines (as indicated in Line Project APHbl-5). The majority of these changes involved changes in selection methods which will be discussed in a later section. However, a change was also initiated in the mating system in four inbred lines of Rambouillets. Alternative outcrossing (2 years) and inbreeding (4 years) is the system planned for these lines, with outbred sires to be used for outcrossing in two of the lines and inbred sires to be used for outcrossing in two lines. In the fall of 1953, line 25 was outcrossed to an inbred ram obtained from Montana State College, line 29 was outcrossed to an outbred ram from the selected control group of this station, line 37 was outcrossed to an inbred ram from line 32, and line 45 was outcrossed to an outbred ram obtained from New Mexico A & M College. In line 32, the homozygous polled ram (7491 DLF) was again mated to his daughters in order to further test whether he carries a gene for cryptorchidism. None of the 12 ram lambs obtained in 1954 from these matings were cryptorchid as were none of the three ram lambs obtained from a similar test in 1952. The probability of obtaining 15 normal ram lambs from sire-daughter matings to a heterozygous ram is 13% (if a simple recessive factor is assumed). It is pointed out that the 1954-55 test results on 7491 DLF reduce this probability to 2%.

Rambouillet cross lines

The line crosses started in 1952 were continued except that line 25 was omitted as a sire line because of its use in the method of alternative outcrossing and inbreeding. Sixteen ewes were taken at random from each of lines 39, 46, 49, 50 and 51. Ten ewes (2 from each line) were assigned at random to each of two rams from lines 26, 35, 36 and 40. Two rams from each of the 9 lines involved in crossing were each mated to four test ewes in order to provide topcross information on these lines. These test ewes were part of a group of 84 head of Rambouillet ewes which were borrowed from Montana State College. The balance of the cross line matings were involved in recurrent selection.

Rambouillet selected control group

This group of about 200 ewes is maintained with major emphasis on selection. An attempt is made in this group to use the mating system which is most promising in terms of the rate of genetic improvement. In earlier years,as many as six rams were used, including at least one ram that had been progeny-tested the previous year. In 1952 an investigation of theoretical and actual results from progeny testing indicated that more rapid progress would result from selecting the best four young (yearling or lamb) rams each year. In 1953, a further theoretical study was made to determine the optimum number of rams which should be used in this group. The results clearly showed that the optimum number of rams for this group is 2 (under the assumptions of 30% heritability and no loss in lamb production). Use of a single ram instead of two rams would be expected to result in a net loss in rate of improvement because the increased loss from inbreeding is greater than the increased gain from selection (on the basis of the reduction in weaning weight with each 1% increase in inbreeding). It is obvious that reductions in the number of rams used will not result in faster improvement if lamb production is reduced. Therefore, it was decided that the optimum number of rams will be approached gradually in order to obtain some estimate of the maximum number of ewes which can be mated successfully to one ram. In 1953, the best 3 yearling rams were each mated with approximately 60 ewes and the best ram lamb was mated with 32 ewes.

Rambouillet recurrent selection

Recurrent selection of sires was continued in lines 20 and 27 and lines 53 and 54. Each of four rams from each line was tested on 4 or 5 ewes from the other line and 5 to 7 test ewes. The sire selected to continue the line was chosen primarily on the basis of the weight, type and condition of his cross line and topcross progeny.

Rambouillet genetically stabilized control group

It is planned that this group will number 100 head of breeding ewes. No selection will be practiced and excess sheep will be eliminated entirely at random. The group was started in 1952 when half of the lambs in the selected control group were assigned at random to the genetically stabilized

control group. The same procedure was followed in 1953 but in 1954 only 14 of each sex were randomized from the selected control group to provide the necessary number. The first within-group matings were made in 1953 when each of seven rams was mated to 4 or 5 ewes. It is planned in the future that 20 yearling rams (chosen at random) will be mated to 5 ewes each. After this group is established, it should serve as a control for all other systems of selection and mating in Rambouillets. Theoretically, little genetic change in this group is expected after the group becomes established. However, an experimental check of its genetic stability is needed.

Targhee lines

A total of 533 ewes were mated in 18 lines. The average number of ewes per line was 29.6 as compared with an average of 31.1 ewes per line bred in 1952. Six ewes which descended from a Border Leicester ram were backcrossed to a polled Rambouillet ram to provide offspring for line 10T.

Targhee cross lines

A small set of line crosses was initiated in 1953. Ewes from 11T and 12T were mated with rams from lines 1T and 10T. It was planned to use two rams per line, but only one ram from line 1T was available at breeding time.

Targhee selected control group

Five or six test ewes were randomized to rams from each of the 18 inbred lines to produce offspring for the selected control group in which selection will be emphasized and inbreeding will be minimized. These matings also provide some information on topcross results from the various lines. The first within-group matings were made in 1953 when eight 2-year-old ewes from the selected control group were mated to one ram from the group.

Targhee recurrent selection

Test matings and recurrent selection of sires were continued in lines 16T, 17T and 18T. Six rams from each line were tested on test ewes and on ewes which were offspring of previous tests of rams from another line.

Columbia lines

A total of 312 ewes were mated in the 10 inbred lines of Columbias. The average number of ewes per line was 31.2 as compared with 34.4 in 1952. Two rams were used in each line in order to obtain a measure of within-line variation for use in comparing cross line and topcross results with results from the inbred lines.

Columbia cross lines

Seven or eight cross line ewes (involving crosses of 2 to 5 lines) were sorted at random to each of two rams from each of the ten lines. However, a restriction was imposed on randomization to prevent any cross line ewe from being mated to a ram from the same line as her sire.

Columbia selected control group

Four test ewes were randomized to each of two sires from each of the 10 lines. The "K" offspring from these matings go into the selected control group, but the "K_2" offspring must be mated to rams from lines in order to produce offspring for the selected control group. Although the main purpose of these matings is to form the selected control group, the matings also provide information on topcross tests of the various inbred lines of Columbias. The first within-group matings occurred in 1953 when 9 two-year-old ewes from the selected control group were mated to one ram from the group.

Summary

In 1953, 58% of the ewes were bred in inbred lines, 15% were bred in or produced offspring for selected control groups, 13% were bred in line crosses, 13% were used for testing rams in recurrent selection or for testing lines in topcrosses, and 1% were bred in the genetically stabilized control group. The latter group is a new addition. The black marker ewes were eliminated. In the other groups the percentage of ewes bred in inbred lines was reduced in comparison with 1952, the percentage of test ewes was increased by the same amount and the percentages of ewes in line crosses and selected controls remained the same. Of the total ewes bred, 47% were Rambouillet, 32% were Targhee and 21% were Columbia. This represents a 1% increase in Rambouillet ewes, a 1% decrease in Columbia ewes and no change in the percentage of Targhee ewes as compared with 1952.

PROGRESS IN DEVELOPING INBRED LINES

Rambouillets

The following table shows the changes in inbreeding in Rambouillet lines since 1938. These data are based on ewes bred.

			Average inbreeding coefficients in percent					
Year lambed	No. of lines	No. of ewes bred	Sires	Dams	Progeny	Increase of progeny over dams	Highest for progeny of any pen	Highest for any individual offspring
1938	20	500	4.0	1.1	3.9	2.8	13.3	37.9
1939	22	560	7.5	3.2	7.2	4.0	30.3	58.3
1940	34	805	6.0	3.6	8.2	4.6	32.6	58.3
1941	36	850	3.3	2.7	8.6	5.9	31.2	47.3
1942	37	1023	4.1	4.0	8.6	4.6	28.7	39.9
1943	30	903	4.4	4.2	8.9	4.7	23.0	36.9
1944	30	908	5.0	5.0	10.3	5.3	22.8	48.0
1945	30	962	6.0	5.8	14.2	8.4	26.8	42.5
1946	30	890	5.9	7.1	14.1	7.0	25.7	39.4
1947	30	897	8.6	8.1	15.6	7.5	29.0	55.2
1948	29	882	14.6	9.7	17.1	7.4	30.5	42.9
1949	29	1002	13.4	11.9	15.8	3.9	32.6	44.2
1950	29	851	13.6	13.6	16.8	3.2	32.4	46.0
1951	29	808	15.3	13.6	19.4	5.8	37.1	50.5
1952	29	740	15.1	13.9	20.6	6.7	39.1	50.5
1953	27	723	19.9	15.0	22.9	7.9	40.0	50.6
1954	27	691	17.5	15.8	20.2	4.4	42.2	51.1

The average inbreeding coefficients for sires, dams and progeny were higher in 1953 than in any previous year. The average increase in inbreeding of progeny from 1938 to 1953 was slightly greater than 1% per year. Of the two lines culled in 1952, line 42 was below the average in inbreeding and line 43 was slightly above average. Removal of these lines would be expected to cause a very slight upward bias in the average inbreeding coefficients for 1953 and later when comparing them with the average inbreeding coefficients for 1948 to 1952.

In 1954, the average inbreeding coefficient for dams was higher than in 1953 but the coefficients for sires and progeny were lower than in 1953. Most of the latter reduction was caused by outcrossing in lines 25, 29, 37 and 45. Average inbreeding coefficients for the remaining 23 lines were 19.3%, 15.7% and 23.3% for sires, dams and progeny, respectively.

The average inbreeding coefficients of all lambs weaned in Rambouillet inbred lines were 21.95% and 19.75%, respectively, for 1953 and 1954. The average inbreeding coefficient for all lambs weaned in 1954 except those from lines 25, 29, 37 and 45 was 22.51%.

The average inbreeding coefficient for ram lambs saved in 1952 was 20.81% as compared with 20.08% for all ram lambs weaned. Ewe lambs saved in 1952 had an average inbreeding coefficient of 19.93% as compared with 20.12% for all ewe lambs weaned.

These inbreeding results indicate that lambs weaned have a lower average inbreeding coefficient than the progeny average calculated on the basis of ewes bred. Part of this difference is probably caused by the lower lamb production of the younger ewes which produce lambs with higher inbreeding coefficients, and part may be caused by a lower rate of survival of lambs with the higher inbreeding coefficients. Comparisons of inbreeding coefficients of selected lambs (lambs saved) with inbreeding coefficients of all lambs weaned indicate that adjustments for inbreeding may not be quite large enough. However, some culling for traits not included in the index may tend to discriminate slightly against the more inbred lambs.

The six highest ranking Rambouillet lines for each of the important traits measured at weaning age in 1953 and 1954 are listed in the next two tables for comparisons with similar tables presented in previous years. As in previous years, the rankings are based on pen averages which have been adjusted for environmental effects. However, the 1953 and 1954 pen averages have also been adjusted to the basis of a standard number of lambs (the largest pen in each year), and the rankings are based on these adjusted values. The adjustment method will be discussed in detail later. Although it changed the ranks of some lines for particular traits, the adjustment for numbers of lambs did not change the ranks of the top six on index for either year.

Rank of Rambouillet Lines in 1953

Trait	1st	2nd	3rd	4th	5th	6th
Body weight	24	54	25	36	26	44
Body type	24	47	54	25*	36*	53
Condition	24	19	25*	54*	53	47
Staple length	44	24	47	37	23*	39*
Open face	40	53	25	49	46	22
Freedom from folds	37	21	32	22*	23*	35* 44*
Index	40	24	25	44	36	54

* Identical adjusted averages.

Nineteen of the 27 lines are included in the table and 12 of these lines were included in 1952. Three lines (40, 44 and 47) have ranked in the high six for one or more traits in each of the last 13 years, but not necessarily for the same trait each year.

The ranks of the six highest lines for weanling traits in 1954 are presented in the following table:

Rank of Rambouillet Lines in 1954

Trait	1st	2nd	3rd	4th	5th	6th
Body weight	24	34	50	32	46	44
Body type	24	53	27	36	34	44
Condition	24	34	21	46	25	53
Staple length	47	25	53	45	37*	44*
Open face	29	44	40	53	36*	51*
Freedom from folds	29	45	28*	37*	49*	25
Index	44	29	47	50	25	39

*Identical adjusted averages

Nineteen of the 27 lines are included in the table and 13 of these lines were included in 1953. Only eight of these lines were included in all three years, 1952 to 1954. Several factors in addition to the choice of sires may greatly influence the ranks of lines. Since 1949 some lines have been used in line crossing for which two sires per line rather than one have been used. Also, the changes in methods of developing lines would be expected to alter the ranks of lines in 1954 and later. For example, of the four lines (25, 29, 37 and 45) which were outcrossed in the fall of 1953, line 29 ranked second among all lines for index in 1954 although it had never ranked in the high six for index in the period from 1944 to 1953. A study of the high six lines for index in the period from 1944 to 1954 shows that 21 of the 27 lines have ranked in the high six for one or more years. Eight lines have ranked in the high six for index in only 1 year, four lines have ranked in the high six for 2 years, two lines have ranked in the high six for 3 years and two lines have ranked in the high six for 4 of the eleven years. Line 25 has been included in the high six for index in 5 years, line 44 has been included in 6 years, line 27 has been included in 7 years, line 50 has been included in 8 years and line 40 has been included in 10 of the eleven years. Line 40 ranked first on index in eight of the eleven years but dropped to eighth rank in 1954. During the period studied, only three other lines (44, 45 and 50) have ranked first in any year.

Targhees

The Targhee inbred lines were established in 1940 and later years. Line 10T was the last line formed and the first offspring were born in the line in 1952. The next table shows the changes in inbreeding in Targhee lines since 1941. The data for 1952 are different from those shown in the last Report because they include line 10T. These data for inbreeding are based on ewes bred.

The average inbreeding coefficients of sires, dams and progeny increased slightly in 1953 and 1954. Formation of new lines has obscured the real increase in inbreeding. Average inbreeding coefficients for the

original 8 lines were 17.5% for sires, 16.6% for dams and 21.1% for progeny in 1954. The average increase in inbreeding coefficients of progeny in these 8 lines was only .3% per year during the first six years of this period but it has been 1.2% per year during the last eight years.

Year lambed	No. of lines	No. of ewes bred	Average inbreeding coefficients in percent					
			Sires	Dams	Progeny	Increase of progeny over dams	Highest for progeny of any pen	Highest for any individual offspring
1941	8	192	8.2	3.5	9.6	6.1	16.4	30.9
1942	8	183	8.5	3.5	10.6	7.1	17.4	34.9
1943	8	202	7.2	3.5	10.6	7.1	22.5	34.9
1944	8	223	8.7	4.6	11.2	6.6	16.0	31.0
1945	8	257	5.0	7.5	13.1	5.6	20.8	35.9
1946	8	245	3.4	7.2	11.5	4.3	18.9	36.2
1947	9	299	4.9	7.2	12.3	5.1	21.9	41.4
1948	13	318	8.1	6.0	13.9	7.9	19.8	44.7
1949	14	409	8.9	5.9	13.0	7.1	23.4	35.2
1950	14	420	7.7	6.1	13.2	7.1	25.5	34.9
1951	17	455	10.1	6.6	14.4	7.8	25.7	40.1
1952	18	480	10.3	7.7	14.7	7.0	28.8	44.1
1953	18	559	11.7	9.1	15.0	5.9	27.1	39.7
1954	18	532	12.7	9.8	16.1	6.3	27.1	44.0

The average inbreeding coefficients for all lambs weaned in the 18 Targhee inbred lines were 13.12% and 15.32%, respectively, for 1953 and 1954.

The average inbreeding coefficient of ram lambs saved from inbred lines in 1952 was 12.18% as compared with 11.37% for all ram lambs weaned, and it was 11.91% for ewe lambs saved as compared with 12.73% for all ewe lambs weaned. In 1953, average inbreeding coefficients were 13.69% for ram lambs saved and 13.33% for all ram lambs weaned, and 12.70% for ewe lambs saved and 12.91% for all ewe lambs weaned. These results include line 10T.

The four highest ranking Targhee lines in 1953 and 1954 for each of the important traits measured at weaning are listed in the next two tables. As in previous years the data are based on weanling pen averages adjusted for environmental effects. However, for 1953 and 1954 the pen averages are also adjusted to the basis of a standard number of lambs per pen by a method which will be described later. This method did not change the ranks of the first four lines on index in 1953 but the ranks of 9T and 1T were reversed in 1954.

Rank of Targhee Lines in 1953

Trait	1st	2nd	3rd	4th
Body weight	1T	3T	10T	17T
Body type	1T	17T	9T	7T
Condition	9T	15T	3T	1T
Staple length	8T	2T*	13T*	18T
Open face	10T	16T	12T	4T
Freedom from folds	13T	14T	1T* 10T*	3T* 4T*
Index	1T	10T	12T	16T

* Identical adjusted averages.

This table includes 15 of the 18 Targhee lines, but only 10 of these lines were also included in 1952. Three lines (1T, 3T and 7T) have been included in the high 4 lines for one or more traits in each of the last four years.

Rank of Targhee Lines in 1954

Trait	1st	2nd	3rd	4th
Body weight	1T	12T	9T	11T
Body type	7T	1T	5T	2T
Condition	2T*	6T*	12T	14T
Staple length	8T	7T	2T	6T
Open face	17T	11T	3T	12T
Freedom from folds	7T	4T	11T*	3T* 5T*
Index	17T	11T	12T	1T

*Identical adjusted averages.

Thirteen of the 18 Targhee lines are included in the table and 10 of these lines were also included in 1953. A survey of the high 4 lines on index from 1950 to 1954 is slightly biased because lines 16T, 17T and 18T did not produce line offspring until 1951 and line 10T did not produce line offspring until 1952. However, 10 of the 18 lines have been included in the high 4 lines on index in one or more of the years from 1950 to 1954. Five lines have been included in only one year, three lines (10T, 11T and 17T) have been included in two years, line 12T has been included in four years and line 1T has been included in the high 4 lines on index in all five years. Line 1T has ranked first on index in three of the five years studied.

Columbias

The following table shows the changes in inbreeding in Columbia inbred lines since 1941. These data are based on ewes bred.

			Average Inbreeding Coefficients in Percent					
Year lambed	No. of lines	No. of ewes bred	Sires	Dams	Progeny	Increase of progeny over dams	Highest for progeny of any pen	Highest for any individual offspring
1941	10	318	12.2	9.6	18.9	9.3	29.4	43.5
1942	10	329	12.8	8.6	15.8	7.1	28.0	40.7
1943	10	357	12.7	7.9	15.9	8.0	23.4	38.1
1944	10	298	11.6	8.8	14.7	5.9	18.3	35.7
1945	10	378	12.2	8.8	15.5	6.7	22.4	42.9
1946	10	446	10.8	9.1	15.2	6.1	19.2	37.2
1947	10	455	12.5	9.1	15.3	6.2	22.4	35.8
1948	10	335	12.9	9.7	15.4	5.7	22.1	38.0
1949	10	381	11.6	11.1	15.9	4.8	21.6	37.8
1950	10	343	15.9	11.5	18.0	6.5	28.3	47.0
1951	10	355	12.6	12.4	17.4	5.0	23.3	34.0
1952	10	331	14.6	13.9	17.9	4.0	24.1	35.6
1953	10	344	15.1	14.9	19.1	4.2	27.4	37.1
1954	10	312	17.4	15.7	20.4	4.7	27.1	41.8

The average change in inbreeding coefficients of Columbia lines since 1941 has been surprisingly small. The use of two sires for line-crossing tests in many lines in many years and lack of adjustment of ram records for inbreeding in the earlier years may provide partial explanations for the small change in inbreeding.

The average inbreeding coefficient of all lambs weaned in Columbia inbred lines was 18.34% in 1953 and 19.93% in 1954.

The average inbreeding coefficient of ram lambs saved in 1952 was 15.98% as compared with 16.09% for all ram lambs weaned, and it was 18.04% for ewe lambs saved as compared with 17.68% for all ewe lambs weaned. In 1953, average inbreeding coefficients were 18.23% for ram lambs saved and 18.56% for all ram lambs weaned, and 18.22% for ewe lambs saved and 18.16% for all ewe lambs weaned. It appears that adjustments for inbreeding are fairly accurate for Columbia lambs.

The four highest ranking Columbia lines in 1953 and 1954 for each of the important traits measured at weaning are listed in the next two tables. As in previous years the data are based on weanling pen averages adjusted for environmental effects. However, for 1953 and 1954 the pen averages are also adjusted to the basis of a standard number of lambs by a method which will be described later. This method did not change the ranks of the first four lines on index in 1953, but the ranks of lines 9 and 2 were reversed in 1954.

Rank of Columbia Lines in 1953

Trait	1st	2nd	3rd	4th
Body weight	7	3	10	5
Body type	3	1	5	10
Condition	3	10	7	5
Staple length	8	2	1	7
Wool fineness	7	2	8	1* 3*
Index	7	3	5	1

*Identical adjusted averages.

This table includes 7 of the 10 Columbia lines and all seven lines were included in 1952.

Rank of Columbia Lines in 1954

Trait	1st	2nd	3rd	4th
Body weight	9	10	5	7
Body type	7	1	2	3
Condition	9	10	4	5
Staple length	7	2	1	3
Wool fineness	9	1	2	6
Index	7	5	10	2

This table includes 9 of the 10 Columbia lines but only 6 of these lines were included in both 1953 and 1954. Five lines have ranked in the high four on one or more traits in each of the last five years. Indexes on Columbia lambs were first calculated in 1951. Seven of the ten Columbia lines have ranked in the high four on index in one or more years since 1951, but only line 7 has ranked in the high four in all four years.

RECURRENT SELECTION

The objective of recurrent selection as it is being practiced at this station is to develop specific and/or general combining ability in particular inbred lines that are in their developmental stages. This is being attempted by selecting sires for these lines on the basis of their combining abilities with random individuals from another particular inbred line and/or from noninbred and unrelated test stock.

Initial (mass) selections of rams to be tested were made at weanling age and were based on traits (face covering, neck folds, and staple length) in which the genetic portion of the variance was thought to be largely additive in nature. A special index based on these traits alone has been developed for use in this early phase of recurrent selection. A similar index developed for use on yearling traits included clean fleece weight, staple length, face covering score, and neck folds score. Final (mass) selection of rams to be tested was based on this yearling index.

The rams selected from the tested groups to continue the lines involved in recurrent selection were chosen primarily on the basis of index evaluations of the weight, type, and condition of their test progeny. These progeny included both line-cross and top-cross offspring for Rambouillet rams but only top-cross offspring for Targhee rams. The special index used for this selection emphasizes traits in which a substantial portion of the genetic variance is thought to be nonadditive in nature. Detailed information on each of the above recurrent selection indexes is contained in the 15th annual report.

Rambouillets

Certain weanling trait averages for progeny from lines, line crosses, and top crosses in the recurrent selection program are presented in the next table. The averages have been adjusted for environmental effects, inbreeding, number of lambs, and relationship among lambs except that the inbreeding of cross-line and top-cross offspring is unknown since only intra-line relationships between parents are available.

Weanling Averages of 1953 and 1954 Progeny of Rambouillet Lines, Line Crosses and Top Crosses in Recurrent Selection

		Lines		Line crosses*		Top crosses*			
Trait	Year	20	27	27x20	20x27	20xT**	27xT	20x(27xT)	27x(20xT)
No. of offspring	1953	27	25	14	19	16	14	6	5
	1954	15	26	14	20	17	19	11	10
Weaning weight (lbs.)	1953	71.2	82.2	78.4	75.7	80.6	84.1	75.0	86.5
	1954	71.2	79.2	72.6	72.7	76.6	78.8	78.0	73.6
Type (score)	1953	2.1	2.0	2.1	2.2	1.9	2.1	2.3	1.9
	1954	2.2	1.9	2.2	2.2	2.2	2.0	2.1	2.2
Condition (score)	1953	2.4	2.4	2.4	2.7	2.3	2.3	2.8	2.3
	1954	2.5	2.5	2.5	2.6	2.4	2.3	2.4	2.5
Index (nonadditive)	1953	64.7	75.9	71.8	68.6	74.4	77.7	67.7	80.4
	1954	64.4	73.0	65.7	65.7	70.0	72.6	71.5	66.8

		Lines		Line crosses		Top crosses			
Trait	Year	53	54	54x53	53x54	53xT	54xT	53x(54xT)	54x(53xT)
No. of offspring	1953	20	23	21	22	14	20	3	5
	1954	28	20	25	21	16	14	7	11
Weaning weight (lbs.)	1953	76.7	87.0	76.2	75.2	80.4	79.8	71.7	84.3
	1954	76.7	78.2	75.0	74.3	79.9	79.7	77.8	78.0
Type (score)	1953	1.9	1.7	2.2	2.0	2.0	1.9	2.2	2.1
	1954	1.8	2.0	2.1	2.2	1.9	2.1	2.0	2.2
Condition (score)	1953	2.4	2.3	2.5	2.5	2.5	2.3	2.7	2.0
	1954	2.3	2.4	2.4	2.7	2.0	2.4	2.2	2.0
Index (nonadditive)	1953	70.6	81.2	69.4	68.8	74.1	73.6	64.7	78.2
	1954	70.7	71.8	68.4	67.2	74.2	73.1	71.7	72.0

* The Sire line is listed first in all crosses.

** T denotes ewes from noninbred and unrelated test stock.

The adjustment for number of lambs and relationship among lambs from the same progeny group in recurrent selection test matings was made as follows:

$$A_x = \bar{A}_o + \frac{N_o}{N_x} \frac{\left[1 + (N_x - 1)\, g^2 r\right]}{\left[1 + (N_o - 1)\, g^2 r\right]} (A_o - \bar{A}_o)$$

where A_x = A_o for a particular trait adjusted to the basis of a standard number, N_x, of offspring with average relationship, r,

A_o = average of all lambs of the same kind by the same sire,

$\bar{A}_o$ = average of all lambs of the same kind from all sires in the same line,

N_o = actual number of lambs of the same kind by the same sire,

N_x = 7 for Rambouillets and 9 for Targhees,*

g^2 = heritability,

r = average relationship among half sibs of the same kind by the same sire,

and $g^2r \approx$ phenotypic correlation between half sibs.

* The standard numbers may be changed each year to be the largest number in any pen of that breed. The same standard number for all kinds of lambs from each breed was used.

The T ewes involved in the top crosses were unrelated and noninbred Rambouillet test ewes. The line x T ewes, i.e., top-cross ewes, were offspring of T (test) ewes mated to recurrent selection sires. One should be aware that a single tested sire is involved in each within-line mating but that 3 or 4 untested sires are involved in each of the line crosses and top crosses. The rams tested in 1953 were the first rams having tested sires.

Averages for line-cross progenies of lines 20 and 27 were about intermediate between those for the parental lines in both 1953 and 1954. The line crosses averaged slightly better than parent line 20 and poorer than parent line 27. Line 53 and 54 line-cross progeny were poorer than either parent line progeny in 1953 and 1954. The line-cross averages for 1953 and 1954 showed no important advantage for any one line cross when compared on the basis of the nonadditive index. In general the top-cross progeny were superior to the line-cross progeny. At least part of this superiority was the result of the superior maternal environment provided by the noninbred top-cross and test dams.

These data indicate, in general, that the combining abilities of the lines in these particular crosses at this stage of development are not greatly different from what one might expect to obtain from additive gene

effects. There is some evidence, however, that the specific combining ability of line 53 with 54 might be somewhat poor. Line 27 appears to have the best general combining ability, with line 54 being a close second.

The selection differentials, based on weighted progeny averages, for rams selected for use in recurrent selection lines are shown in the next table.

Selection Differentials Based on Weighted Progeny Averages for Rambouillet Rams Used in Recurrent Selection Lines*

Year	Line	Ram used	Rank of progeny	No. of progeny of selected ram	No. of progeny of all rams	Selection differentials			
						Weight (lbs.)	Type (score)	Condition (score)	Non-additive index
1953	20	3457RW	1	9	41	.92	.03	.07	1.09
	27	3520RW	1	10	33	1.97	.03	.08	2.02
	53	1692RW	1	10	39	2.10	.16	.10	2.15
	54	1930RW	1	13	46	.98	.04	.06	1.00
1954	20	3302RW	1	12	48	.55	.01	.00	.57
	27	3643RW	1	11	43	2.43	.03	.00	2.49
	53	528XW	1	8	44	1.14	.02	.01	1.15
	54	549XW	1	13	50	1.00	.02	.00	1.09

* The selection differentials indicate how much better (positive) or poorer (negative) the average of any selected ram's progeny was than the average of all progeny from all rams tested in his line. See the text for the method of weighting line-cross and top-cross progeny.

Inconsistencies between line-cross and top-cross results for the same ram, in many instances, pointed out the need for some method of combining these results to obtain a properly weighted net evaluation of the ram. Hence, for the selection of rams in 1953 and 1954 the line-cross and top-cross indexes were arbitrarily weighted and combined. For these particular comparisons it was decided arbitrarily that line-cross information was worth 4 times as much as initial top-cross information since emphasis for these lines was being placed on specific combining ability. On the basis of these weights, those top-cross progeny from line sires mated to top-cross dams were given an intermediate weight of 2.5 in contrast to the weight of 1.0 given top-cross progeny from test dams.

The above method of weighting lead to the selection of the rams listed in the table with selection differentials as indicated.

Targhees

Recurrent selection for general combining ability is being practiced on 3 lines of Targhees (16T, 17T and 18T). In 1953 and 1954 six rams from each line were tested on groups of 8 to 12 ewes each. The test ewes were

Weanling Averages of 1953 and 1954 Progeny of Targhee Lines, and Top Crosses in Recurrent Selection

		Lines			Initial Top Crosses			Second Top Crosses		
Trait	Year	16T	17T	18T	16TxTest	17TxTest	18TxTest	16Tx17TxT	17Tx18TxT	18Tx16TxT
No. of offspring	1953	24	36	52	35	35	37	12	24	30
	1954	22	39	52	39	16	14	27	42	51
Weaning weight	1953	79.04	84.45	80.34	82.11	82.76	81.88	77.26	79.76	79.94
	1954	88.60	92.44	88.34	88.78	93.46	87.09	91.06	89.51	88.94
Type score	1953	1.98	1.81	1.94	2.04	1.93	1.98	2.09	2.04	1.99
	1954	1.92	1.74	1.84	1.92	1.66	1.99	1.77	1.84	1.82
Condition score	1953	2.22	2.02	2.16	2.02	1.93	1.88	1.99	2.04	1.96
	1954	2.08	2.04	1.98	1.96	1.77	1.98	1.92	1.96	2.07
Index (nonadditive)	1953	72.92	78.87	74.36	76.12	77.07	76.15	71.21	73.74	74.10
	1954	82.75	86.96	82.75	83.07	88.44	81.23	85.67	83.94	83.28

unrelated, noninbred Targhee ewes somewhat comparable to the Rambouillet test ewes. The average relationships between the test ewes and the rams to which they were mated were either low or zero.

All averages for lines were adjusted for environmental effects, inbreeding, numbers of lambs, and relationship among lambs in the same manner as the Rambouillet averages. Averages for top crosses were adjusted for all of the above factors except inbreeding. The preceding table shows that straight-line progeny from 17T excelled the other two lines for progeny index in both years, this same superiority being evident also in 1951 and 1952. Line 17T also exhibited a somewhat better general combining ability (for index) in the initial top crosses than either line 16T or 18T. In subsequent top crosses, however, differences among these lines seem to be random.

Selection differentials based on progeny averages for rams selected to continue the recurrent selection lines are shown in the following table. The progeny averages were weighted in the same manner as those for Rambouillets.

Previous experience has shown it desirable to use untested rams in lieu of tested rams ranking below the average of all rams tested, in the event the superior tested rams were not available at breeding time. Consequently, an untested ram was used in 1953 in line 16T. Using this same criterion for selection, a fourth ranking tested ram was used in line 18T inasmuch as the first three ranking rams had poor semen quality and the fourth ram's index was still above the average of all rams tested.

It is apparent that many of the selected differentials were low even when first choice rams were used.

Selection Differentials Based on Weighted Progeny Averages for Targhee Rams Used in Recurrent Selection Lines*

						Selection Differentials			
Year	Line	Ram used	Rank of progeny	No. of progeny of selected ram	No. of progeny of all rams	Weight (lbs.)	Type (score)	Condition (score)	Non-additive index
1953	16T	6752T	Not tested						
	17T	6368T	1	10	59	3.39	.02	.12	3.52
	18T	6029T	4	12	67	.46	.10	-.07	.59
1954	16T	7012T	1	7	66	.47	.01	.00	.53
	17T	6368T	1	9	58	1.86	.02	.01	2.00
	18T	6029T	1	12	65	.73	.04	-.01	.79

* The selection differentials indicate how much better (positive) or poorer (negative) the average of any selected ram's progeny was than the average of all progeny from all rams tested in his line. See the text for the method of weighting line-cross and top-cross progeny.

LINE CROSSES

Rambouillets

The testing of some Rambouillet lines for combining ability was continued in 1952-53 and 1953-54 by mating each of the 2 rams from each sire line to two randomly chosen ewes from each of 4 or 5 dam lines plus half of the ewes from his own line.

Some preliminary comparisons of sire lines on results from line-cross lambs born in 1953 and 1954 are given in the next table. These data have been corrected for environmental effects and inbreeding except that data for line-cross offspring have not been corrected for any inbreeding which may have occurred because of possible relationship between line-cross parents or for the maternal effect on weanling traits due to the inbreeding of the dams. The inbreeding correction used for the inbred lambs, however, in addition to correcting for the inbreeding of the lambs, roughly corrects for the above mentioned maternal effect. Lines as well as sire groups within lines have been given equal weight in the averages which are given for comparison.

Line 40 appears to have the highest general combining ability with the particular dam lines involved of any of the sire lines tested. This line also appears to exhibit more heterosis than the other sire lines. Line-cross offspring sired by line 40 rams were superior to the other line-cross groups in 24 of 28 comparisons and were superior to straight line offspring from their parental lines in 12 of 16 comparisons. Line 26 appears to rank second in general combining ability followed next in order by lines 36 and 35. It is noteworthy, that although line 25 was one of the superior sire lines on its own overall merit, it was poorest of all in combining ability for overall merit (index).

Targhees

The testing of Targhee lines in line crosses was begun in the fall of 1953 by randomly mating Targhee ewes from lines 11T and 12T to 1 ram from line 1T and 2 rams from line 10T. Each ram was also mated to ewes from his own line.

Some preliminary results based on 1954 offspring are presented in the second following table. These data have been corrected for environmental effects and inbreeding in the same manner as the Rambouillet data and are subject to similar limitations. Again, lines and rams within lines have been given equal weight in the averages which are given for comparison.

The line-cross offspring from both lines were inferior in most comparisons to the straight-line offspring thus indicating poor combining ability and no heterosis for these crosses. The line-cross offspring from line 10T were inferior to parent line offspring in both weaning weight and index, whereas the line-cross offspring of line 1T were inferior to the parent lines in all of the characteristics compared.

Average Weaning Weights, Type Scores, Condition Scores, and Indexes of Rambouillet Lambs from Sire Lines, Line Crosses, and Dam Lines in 1953 and 1954

			Sire Line Numbers				
		Year	25	26	35	36	40
No. of lambs	Sire line	1953	28	28	23	25	28
		1954		27	25	24	27
	Line crosses	1953	20	18	17	18	21
		1954		24	22	16	22
	Dam lines*	1953	98	98	98	98	98
		1954		127	127	127	127
Average weaning weights	Sire line	1953	85.7	85.0	79.0	85.2	79.6
		1954		78.1	79.2	79.5	78.8
	Line crosses	1953	82.8	82.6	82.7	83.2	85.0
		1954		76.7	80.6	74.3	78.7
	Dam lines	1953	80.4	80.4	80.4	80.4	80.4
		1954		78.0	78.0	78.0	78.0
Average type scores	Sire lines	1953	1.76	1.98	2.14	1.75	2.12
		1954		2.22	2.11	1.86	2.22
	Line crosses	1953	2.02	2.00	2.08	1.96	1.85
		1954		2.12	1.99	2.38	2.22
	Dam lines	1953	2.02	2.02	2.02	2.02	2.02
		1954		2.16	2.16	2.16	2.16
Average condition scores	Sire line	1953	2.25	2.38	2.72	2.53	2.54
		1954		2.50	2.59	2.37	2.35
	Line crosses	1953	2.26	2.48	2.50	2.37	2.34
		1954		2.48	2.48	2.78	2.42
	Dam lines	1953	2.47	2.47	2.47	2.47	2.47
		1954		2.49	2.49	2.49	2.49
Average indexes**	Sire line	1953	141.3	132.5	132.2	139.1	143.9
		1954		130.8	128.5	137.3	136.6
	Line crosses	1953	129.0	137.2	132.2	136.8	146.8
		1954		135.5	135.1	133.6	140.0
	Dam lines	1953	132.2	132.2	132.2	132.2	132.2
		1954		134.0	134.0	134.0	134.0

* The dam-line offspring presented for a convenient comparison in each sire-line column are identical because identical dam lines are involved in the line crosses with each sire line.

** All indexes shown in this table are the regular selection indexes which include face covering, neck folds, staple length, weight, type, and condition.

Average Weaning Weights, Type Scores, Condition Scores, and Indexes of Targhee Lambs from Sire Lines, Line Crosses, and Dam Lines in 1954

			Sire Line Numbers	
		Year	1T	10T
No. of lambs	Sire line	1954	23	27
	Line crosses	1954	14	18
	Dam lines*	1954	75	75
Average weaning weight	Sire line	1954	97.3	92.8
	Line crosses	1954	88.8	92.3
	Dam lines	1954	93.8	93.8
Average type scores	Sire line	1954	1.57	1.62
	Line crosses	1954	1.86	1.70
	Dam lines	1954	1.80	1.80
Average condition scores	Sire line	1954	1.92	1.95
	Line crosses	1954	2.21	1.82
	Dam lines	1954	2.05	2.05
Average indexes**	Sire line	1954	161.8	160.3
	Line crosses	1954	158.3	159.3
	Dam lines	1954	164.1	164.1

* The dam-line offspring presented for a convenient comparison in each sire-line column are identical because identical dam lines are involved in the line crosses with each sire line.

** All indexes shown in this table are the regular selection indexes which include face covering, neck folds, staple length, weight, type, and condition.

Columbias

Cross-line Columbia ewes were randomly mated to 2 rams from each of lines 2, 3, 4, 6, 8, 9, and 10 in 1952 and lines 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 in 1953. Each ram was mated to half of the ewes from his own line in addition to the cross-line ewes. Some preliminary results are presented in the next table. These data have been adjusted for environmental effects and inbreeding in the same manner as the Rambouillet and Targhee data. Lines and rams within lines have been given equal weight in the averages which are given for comparison.

Line-cross offspring were generally superior to straight-line (sire line) offspring in overall merit as shown by the index. The exceptions were lines 5 and 7, and line 9 in 1954. Line 3 produced the best straight-line offspring in 1953 and the best line-cross offspring in both years, as shown by index. Lines 5 and 7 were the two most superior lines in overall merit on the basis of sire-line offspring but were the two most inferior lines on the basis of line-cross performance, thus indicating poor combining ability for these particular crosses.

Average Weaning Weights, Type Scores, Condition Scores, and Indexes of Columbia Lambs from Sire Lines and Line Crosses in 1953 and 1954

			Sire Line Numbers									
			2	1	3	4	5	6	7	8	9	10
No. of lambs	Sire line	1953	38		31	33		13		32	20	39
		1954	37	28	33	29	31	17	41	21	14	36
	Line crosses	1953	19		17	23		22		19	24	19
		1954	13	16	12	16	15	16	13	15	20	16
Average weaning weight	Sire line	1953	80.1		88.2	80.4		81.0		80.2	82.0	85.5
		1954	90.9	88.0	91.0	93.0	94.1	87.7	93.1	87.8	96.5	94.4
	Line crosses	1953	83.2		88.2	83.9		82.2		82.1	83.3	87.9
		1954	92.5	91.0	97.4	93.7	85.6	93.7	91.0	91.2	91.9	94.1
Average type score	Sire line	1953	1.78		1.55	1.84		1.88		1.92	1.86	1.74
		1954	1.50	1.46	1.54	1.61	1.70	1.60	1.48	1.73	1.51	1.64
	Line crosses	1953	1.72		1.64	1.89		1.84		1.88	1.98	1.95
		1954	1.70	1.52	1.48	1.86	1.78	1.56	1.72	1.58	1.65	1.60
Average condition score	Sire line	1953	2.06		1.76	2.08		2.10		2.08	1.96	1.90
		1954	1.98	1.96	1.89	1.71	1.82	1.96	1.96	2.05	1.45	1.63
	Line crosses	1953	1.87		1.78	1.84		2.12		1.97	1.82	1.54
		1954	1.72	1.86	1.68	1.95	2.08	1.62	1.76	1.60	1.64	1.62
Average indexes*	Sire line	1953	121.2		126.4	122.8		122.3		123.6	118.5	124.0
		1954	135.1	131.0	134.4	133.6	136.4	128.7	138.4	130.7	134.6	135.7
	Line crosses	1953	122.7		128.8	127.7		123.4		125.6	120.2	125.6
		1954	136.1	134.9	141.5	136.2	129.2	133.3	132.1	133.9	132.8	138.2

* All indexes shown in this table are the regular selection indexes which include face covering, neck folds, staple length, weight, type, and condition.

The advantage in index of all line-cross offspring over all inbred offspring was 1.7% in 1953 and 0.7% in 1954. Adjustments for possible inbreeding of line-cross offspring would increase this advantage slightly. It should be mentioned, however, that unlike the Rambouillet and Targhee dams used in line crosses, the Columbia cross-line dams were relatively noninbred. Consequently, the maternal effect on Columbia line-cross offspring was relatively more favorable than that on straight-line offspring, tending to exaggerate the advantage of the line crosses. Conversely, any superiority of line-cross offspring of Rambouillet or Targhee ewes was minimized to the extent that the correction for inbreeding of straight-line offspring also reflected some portion of the maternal effect associated with inbreeding of their dams. No such partial correction for the maternal effects of inbreeding was available for the noninbred line-cross offspring.

SELECTED NONINBRED CONTROL AND GENETICALLY STABILIZED CONTROL GROUPS

Selected, noninbred breeding groups have been started in each of the three station breeds to serve as control groups to compare the improvement resulting from selection accompanied by the formation of inbred lines with that resulting from selection without inbreeding.

In addition to the selected control groups, a genetically stabilized control group has been established in the Rambouillet breed. The purpose of this stabilized group is to provide a control for year to year environmental changes affecting the inbred lines and the selected control group of Rambouillets. Artificial selection in the group is intended to be random with two exceptions. First, ewes are being culled at random within each age group to maintain an age distribution characteristic of the entire flock at the station; and second, at least one randomly chosen ram lamb offspring from each sire group of five ewes in any particular year is used in breeding the following year. This random breeding group will also be used to obtain estimates of potential gains from selection by taking data from the group and applying various selection practices on paper; to obtain estimates, unbiased by selection, of relationships between traits and of repeatabilities and heritabilities of all traits; and to provide an experimental group on which new methods of evaluation (new scores, measures, indexes, different methods of adjusting records, etc.) may be tested, unconfounded by selection, before applying them to the whole flock. Similar stabilized control groups will be established for the Targhee and Columbia breeds as soon as possible.

Rambouillet

The selected control group of Rambouillets was started in the fall of 1947. In the first two years it was necessary to use sires from outside the group. The majority of lambs born in 1950 and all lambs born since that time were sired by rams selected from within the group.

The genetically stabilized control group was started in 1952 by sorting out a random half of all offspring born in the selected control group. This procedure was repeated in succeeding years until 100 ewes of breeding age were obtained.

Comparisons of the averages for various traits of all weanling Rambouillet offspring of the inbred lines, selected control group and the stabilized control group for 1948 through 1954 are shown in the next table. Adjustments were made for environmental effects and inbreeding.

Group	Year	No. of lambs	Inbr. coef. %	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condi-tion score	Neck folds score	Index
Inbred lines	1948	871	15.8	4.18	3.16	73.97	1.95	2.21	1.21	113.5
	1949	838	14.9	4.04	3.34	76.59	1.94	2.67	1.20	123.3
	1950	647	15.8	4.10	3.44	78.67	1.69	2.37	1.12	122.0
	1951	711	18.4	3.73	3.49	80.30	1.91	2.60	1.14	132.8
	1952	416	20.1	3.77	3.40	77.15	2.23	2.57	1.07	129.1
	Ave.		17.0	3.96	3.37	77.34	1.94	2.48	1.15	124.1
	1953	613	22.0	3.84	3.56	81.28	1.96	2.45	1.11	131.8
	1954	659	19.8	3.63	3.82	78.38	2.10	2.44	1.15	133.4
	Ave.		20.9	3.74	3.69	79.83	2.03	2.44	1.13	132.6
Selected control	1948	180	1.9	4.01	3.31	72.70	1.92	2.32	1.23	116.5
	1949	189	1.9	4.06	3.53	75.25	1.89	2.70	1.20	123.2
	1950	170	1.9	3.69	3.54	78.50	1.67	2.40	1.16	128.9
	1951	215	2.8	3.35	3.60	79.96	1.89	2.61	1.13	139.1
	1952	130	2.4	3.50	3.58	76.84	2.32	2.53	1.10	133.5
	Ave.		2.2	3.72	3.51	76.65	1.94	2.51	1.16	128.2
	1953	205	2.4	3.30	3.88	83.02	1.92	2.38	1.10	143.4
	1954	227	2.5*	3.28	4.02	77.33	2.05	2.52	1.21	138.9
	Ave.		2.5	3.29	3.95	80.18	1.98	2.45	1.16	141.2
Stabi-lized control	1954	21	2.5*	3.52	3.94	76.82	2.03	2.31	1.30	131.6

* Inbreeding coefficient estimated, but not calculated in the conventional manner.

Differences between the inbred lines and the selected noninbred control group in weanling trait averages (adjusted for the deleterious effects of inbreeding) for the years 1948 through 1952 were small. The control group was slightly more open faced, had slightly longer staple, lighter weaning weights and had a slightly higher index. However, it was virtually identical to the inbred lines in type, condition and neck folds score.

The selected control group has made relatively greater improvement in recent years than have the inbred lines as may be illustrated by the average weanling traits for the years 1953 and 1954. The selected control group excelled the inbred lines in all traits except condition score and neck fold score for which both groups were essentially identical. It also excelled the inbred lines on index by a rather large margin.

The first weanling averages for the stabilized control group were obtained in 1954. This group was superior to the other two groups in type and condition, intermediate between the selected control group and the inbred lines in face covering score and staple length, and inferior to either of the other groups in weaning weight, neck fold score, and index.

Targhees

The Targhee selected control group was initiated in 1952 by randomizing 95 test ewes to the 18 rams used in inbred lines. Offspring from these and future matings will be the foundation for a selected control group in which selection will be emphasized and inbreeding will be minimized. The first within-group matings were made in 1953 when 8 two-year-old ewes from the selected control group were mated to one ram from the group. The 1954 weanling averages for the selected control group and the inbred lines may be compared in the next table. As was done for the Rambouillets, these data were adjusted for the effects of environment and inbreeding.

Group	Year	No. of lambs	Inbr. coef. %	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
Inbred lines	1954	567	15.32	3.15	4.68	90.08	1.78	2.02	1.09	155.5
Selected control	1954	9		3.27	4.77	85.92	1.96	2.25	1.05	152.5

Columbias

The Columbia selected control group also was initiated in 1952 by randomizing 81 test ewes to the 17 rams used in inbred lines. Offspring from these and future matings will be the foundation for a selected control group of the same nature as the Rambouillet and Targhee selected control groups. The first within-group matings were made in 1953 when 9 two-year-old ewes from the selected control group were mated to one ram from the group. The 1954 weanling averages for the selected control group and the inbred lines may be compared in the next table.

Group	Year	No. of lambs	Inbr. coef. %	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
Inbred lines	1954	287	19.93	2.84	5.19	91.79	1.57	1.86	1.11	134.5
Selected control	1954	5		2.27	5.49	92.33	1.52	1.68	1.00	134.9

As was true for the Targhee comparisons, the results are inconclusive as yet and are presented as a matter of interest only.

SELECTION PRACTICED ON WEANLING LAMBS

Weanling selection differentials represent the average differences between selected lambs and all lambs weaned after corrections for environmental influences have been made. Considerable selection is practiced on rams at later ages, but most of the effective selection of ewes for fleece and body traits is made at weanling age. The relative intensity of selection for each trait was obtained by dividing the selection differential by the standard deviation for each breed.

The expected genetic gain per generation from selection in only one sex is the selection differential times one-half of the heritability. The sum of the products for both sexes gives the net expected genetic gain per generation from selection practiced at weanling age on both sexes. These are only tentative gains however, because not all lambs saved at weaning will be permitted or able to produce offspring.

Heritability estimates for all the traits except side grade and index were obtained from 1941 and 1942 weanling lambs for Rambouillets and from 1941 to 1944 weanling lambs for Columbias and Targhees. Average estimates for Corriedale, Columbia and Targhee lambs were used for the latter two breeds as there were insufficient numbers within each breed to obtain reliable estimates. Heritabilities of the Rambouillet, Targhee and Columbia weanling indexes were calculated from information used in forming the indexes. The heritability for side grade was obtained from 1950 weanling lambs.

Annual genetic improvement, estimated from selections at weanling age, depends partly on the length of the generation interval, which is the average age of the parents when their offspring are born. The estimated annual genetic improvement resulting from weanling selections is the expected net gain per generation from selection of both sexes divided by the generation interval. The generation interval which should be applied to these data would be the age when these offspring produce progeny. This can only be estimated now from the average age of the present parents.

Rambouillets

The percentage of lambs saved in the inbred lines was greater in 1952 and 1953 than in 1951. This was due principally to the occurrence of vibriosis in the flock in 1952 which greatly reduced the total lamb crop. An effort was still being made in 1953 to compensate for the lower number of lambs saved in 1952. In 1953, 54% of the ram lambs and 74% of the ewe lambs were saved as compared with 53% and 75% in 1952 and 38% and 68% in 1951.

Selection differentials and expected gains for weanling traits in Rambouillet inbred lines in 1952 and 1953 are shown in the following table.

Selection differentials for Rambouillet lambs generally were lower for all traits in 1952 than in 1953 or 1951. This was largely due to the effect of vibriosis on the lamb crop in 1952. The relative intensity

	Year	Face covering score	Staple length (cm.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
Heritability		56%	40%	30%	13%	4%	39%	48%
RAMS								
Selection differential	1952	.11	.07	2.38	.11	.05	.04	4.52
	1953	.27	.08	3.84	.17	.17	.04	7.46
Expected genetic gain/generation	1952	.031	.014	.357	.007	.001	.008	1.085
	1953	.076	.016	.576	.011	.003	.008	1.790
EWES								
Selection differential	1952	.06	.02	1.33	.07	.06	.02	2.08
	1953	.07	.06	1.32	.08	.09	.02	2.26
Expected genetic gain/generation	1952	.017	.004	.200	.005	.001	.004	.499
	1953	.020	.012	.198	.005	.002	.004	.542
EWES + RAMS								
Expected genetic gain/generation	1952	.048	.018	.557	.012	.002	.012	1.584
	1953	.096	.028	.774	.016	.005	.012	2.332
Selection differentials expressed as fractions of a standard deviation								
RAMS	1952	.18	.15	.28	.23	.12	.13	.30
	1953	.44	.17	.45	.35	.40	.13	.50
EWES	1952	.10	.04	.16	.15	.14	.07	.14
	1953	.11	.13	.16	.17	.21	.07	.15

of selection in ram lambs was greatest for index closely followed by that for weaning weight. It was greatest for weaning weight and type score in 1952 and for condition score and type score in 1953 for ewe lambs.

The average ages of Rambouillet sires and dams when their offspring were born, for all lambs weaned, are given in the following table:

	Average age of:		
Year lambs were born	Sires (years)	Dams (years)	Sires & Dams (years)
1944	3.42	4.36	3.890
1945	3.45	4.28	3.865
1946	2.72	4.31	3.515
1947	2.38	4.31	3.345
1948	1.96	4.26	3.110
1949	2.23	4.26	3.245
1950	2.47	3.95	3.210
1951	2.10	4.24	3.170
1952	2.87	4.42	3.645
1953	2.48	4.41	3.445

Generation length based on both sires and dams was longer in 1952 than any year since 1945 and longer in 1953 than in any year since 1946 except 1952. This again reflects the impact of a reduced replacement rate due to vibriosis.

The estimated annual genetic gains from weanling selections of Rambouillets from 1944 to 1953 are shown in the following table:

Year	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
1944	.019	.011	.233	.009	.002	.029	.938
1945	.024	.014	.306	.011	.002	.019	1.005
1946	.041	.015	.325	.006	.002	.017	1.179
1947	.040	.015	.374	.007	.001	.018	1.362
1948	.034	.015	.383	.008	.002	.006	1.131
1949	.032	.014	.339	.006	.002	.009	1.048
1950	.034	.009	.239	.006	.001	.006	.875
1951	.031	.008	.259	.007	.001	.009	.875
1952	.013	.005	.153	.003	.001	.003	.435
1953	.028	.008	.225	.005	.001	.003	.677

The rates were as low or lower in 1952 than for any previous year. Similarly, estimated genetic gains in 1953 were as low or lower than for any previous year except 1952, for all weanling traits except face covering score. These genetic gains can be altered by post-weaning selection although the intensity of such selection is limited by the intensity of selection practiced at weaning age.

Targhees

A higher proportion of Targhee ram lambs was saved in 1952 because of vibriosis than in any previous year since 1944. A higher proportion of ewe lambs also was saved in this year than in any other year since 1947. In 1953, the proportion saved was considerably smaller than in 1952 and smaller than for a number of previous years.

Selection statistics for Targhee weanling lambs from inbred lines in 1952 and 1953 are given in the following table.

	Year	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
Heritability		46%	43%	17%	7%	21%	8%	48%
RAMS								
Selection differential	1952	.09	.01	1.48	.09	.10	.01	2.04
	1953	.18	.04	3.00	.16	.14	.05	5.35
Expected genetic gain/generation	1952	.021	.002	.126	.003	.010	.000	0.490
	1953	.041	.009	.255	.006	.015	.002	1.284
EWES								
Selection differential	1952	.06	.00	1.08	.07	.11	.01	1.18
	1953	.16	.05	1.61	.07	.10	.03	3.86
Expected genetic gain/generation	1952	.014	.000	.092	.002	.012	.000	.283
	1953	.037	.011	.137	.002	.010	.001	.926
RAMS + EWES								
Expected genetic gain/generation	1952	.035	.002	.218	.005	.022	.000	.773
	1953	.078	.020	.392	.008	.025	.003	2.210
Selection differentials expressed as fractions of a standard deviation								
RAMS	1952	.15	.02	.15	.20	.20	.03	.14
	1953	.30	.09	.30	.35	.27	.17	.36
EWES	1952	.10	.00	.11	.15	.22	.03	.08
	1953	.27	.11	.16	.15	.20	.10	.26

Selection differentials for weanling Targhees were generally lower for both ram and ewe lambs in 1952 than in 1951, due principally to the higher proportions saved in 1952. In 1953, the selection differentials were higher for all weanling traits except staple length and neck folds in ram lambs and weaning weight, type score and condition score in ewe lambs than in 1951.

The relative intensity of selection was highest for condition and type followed by weaning weight and face covering score for ram lambs in 1952. Similarly, the relative intensity of selection in ewe lambs for the same year was highest for condition followed by type, weaning weight and face covering in that order. In 1953, the relative intensity of selection was highest for index, followed by type, and then by weaning weight and face covering in ram lambs, while the greatest intensity of selection in ewe lambs was for face covering followed by index, condition score and weaning weight in that order.

The average age of Targhee sires and dams when their offspring were born are given in the following table:

Year lambs were born	Average age of: Sires (years)	Dams (years)	Sires and Dams (years)
1944	2.90	4.27	3.588
1945	2.15	4.52	3.334
1946	3.32	4.52	3.916
1947	2.39	4.32	3.355
1948	2.02	3.97	2.992
1949	2.36	3.75	3.059
1950	2.06	3.82	2.940
1951	2.15	4.15	3.150
1952	2.38	4.61	3.495
1953	2.27	4.17	3.220

The generation length in Targhees was longer in 1952 than for any previous years since 1946 and longer in 1953 than any year since 1947.

The estimated annual genetic gains for Targhees from weanling selections from 1944 to 1953 are shown in the following table:

Year	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Neck folds score	Index
1944	.009	.009	.085	.003	.006	.002	
1945	.021	-.001	.095	.004	.010	.002	
1946	.008	.013	.115	.003	.006	.001	
1947	.026	.017	.156	.002	.010	.001	.810
1948	.027	.007	.127	.002	.003	.001	.822
1949	.031	.019	.235	.005	.014	.002	1.181
1950	.029	.005	.137	.003	.008	.001	.791
1951	.016	.003	.097	.002	.006	.001	.518
1952	.010	.001	.062	.001	.006	.000	.221
1953	.024	.006	.122	.002	.008	.001	.686

In 1952 these rates decreased rather sharply but increased in 1953 to levels generally above the 1951 levels and approaching the 1950 levels. Again the lower levels of expected genetic gain were due principally to larger proportions saved and a longer generation interval in 1952.

Columbias

A larger proportion of ram lambs were saved in 1952 than in any previous year and a larger proportion of ewe lambs than in any year

since 1948. However, the proportion of lambs saved in 1953 was smaller than in any previous year except 1949 for ram lambs and 1945 and 1951 for ewe lambs.

Selection statistics for Columbia weanling lambs in 1952 and 1953 are given in the following table.

	Year	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Side grade code	Index
Heritability		46%	43%	17%	7%	21%	30%	30%
RAMS								
Selection differential	1952	.08	.04	.76	.04	.07	.03	.56
	1953	.07	.02	5.60	.15	.35	.15	4.60
Expected genetic gain/generation	1952	.018	.009	.027	.001	.007	.004	.084
	1953	.016	.004	.476	.006	.037	.022	.690
EWES								
Selection differential	1952	.05	.02	2.64	.10	.16	.00	1.76
	1953	.07	.07	2.22	.09	.12	.05	2.27
Expected genetic gain/generation	1952	.012	.004	.224	.004	.017	.000	.264
	1953	.016	.015	.189	.003	.013	.008	.340
RAMS + EWES								
Expected genetic gain/generation	1952	.030	.013	.251	.005	.024	.004	.348
	1953	.032	.019	.665	.009	.050	.030	1.030
Selection differentials expressed as fractions of a standard deviation								
RAMS	1952	.19	.05	.06	.09	.14	.03	.05
	1953	.17	.02	.47	.34	.69	.13	.40
EWES	1952	.12	.02	.22	.23	.31	.00	.15
	1953	.17	.09	.19	.20	.24	.04	.20

Selection differentials for Columbia rams were markedly lower in 1952 than in 1951. This is primarily a reflection of the much larger proportion of lambs saved in 1952. Selection differentials for ram lambs in 1953 were higher for weaning weight, condition score and side grade score but lower in face cover score, staple length and type score than in 1951. However, selection differentials for ewe lambs were generally lower in 1953 than in 1951. The expected genetic gain per generation was lower for 1952 in consonance with the lower selection differentials. In 1953, the estimated genetic gain was higher for staple length, weaning weight, condition score and side grade but lower for face cover and type score than in 1951.

The average age of Columbia sires and dams when their offspring were born are given in the following table.

Year lambs were born	Average age of: Sires (years)	Dams (years)	Sires and Dams (years)
1944	2.55	3.98	3.265
1945	2.87	4.12	3.495
1946	2.83	4.26	3.544
1947	2.62	4.36	3.490
1948	2.30	4.30	3.296
1949	2.38	4.41	3.396
1950	2.32	4.58	3.450
1951	2.28	4.83	3.555
1952	2.07	4.83	3.450
1953	2.36	4.22	3.290

The average age of Columbia sires in 1952 was lower than for any previous year listed. This decrease in average age is at least partially due to efforts to shorten generation length. The increase in age of Columbia dams which has occurred up until 1952 has probably come about because of an attempt to maintain numbers in spite of a relatively low reproductive rate and a fairly high culling rate of ewe lambs. The generation length in Columbia dams was shorter than for the other two breeds in 1952 for the first time since 1947. It was shorter than that for Rambouillets but longer than that for Targhees in 1953.

The estimated annual genetic gain for Columbias from weanling selections from 1944 to 1953 are shown in the following table:

Year	Face covering score	Staple length (cms.)	Weaning weight (lbs.)	Type score	Condition score	Side grade code	Index
1944	.007	.005	.076	.002	.004		
1945	.018	.013	.171	.004	.011		
1946	.014	-.001	.087	.002	.006		
1947	.010	.003	.121	.001	.006		
1948	.009	.001	.074	.002	.006		
1949	.005	-.001	.158	.003	.009		
1950	.010	-.003	.075	.001	.004		
1951	.017	.005	.163	.003	.009	-.003	.210
1952	.009	.004	.073	.001	.007	.001	.101
1953	.010	.006	.202	.003	.015	.009	.313

These rates were all lower in 1952 than in 1951 as would be expected from the higher proportion of lambs saved in 1952. The estimated genetic gain in 1953 was higher for staple length, weaning weight, condition score, side grade and index, and lower for only face cover score than in 1951.

LAMB PRODUCTION

A summary of lamb production for inbred lines in the three breeds is presented in the next table. The percent of ewes lambing is based on ewes bred and present at lambing. This may be an indication of ram fertility although the fertility of the ewes also affects it. The percent of lambs born to ewes lambing is based on all lambs born, alive or dead, to ewes actually having lambs. This value minus 100 gives the percent of ewes having twins. The percent of lambs born which were alive and the percent of live lambs which were weaned lead to measures of lamb mortality at birth and from birth to weaning, respectively. The percent of lambs weaned of ewes bred is a combination of the first four values plus any effect of ewe loss after breeding. Weaning weights are obtained when it becomes necessary to remove the ram lambs from the ewes to prevent them from breeding, which is somewhat earlier than customary marketing time. Average age at weaning has decreased in recent years because of slight changes in breeding and weaning dates. The average weaning ages in 1953 were 127.5, 119.4 and 120.0 days and in 1954 were 127.1, 117.7, 118.4 days for Rambouillet, Targhee and Columbia inbred lines, respectively. Pounds of lamb per ewe bred is an overall value that is a combination of the other individual measures. Breeds are not directly comparable because of differences in age of ewes, breeding and weaning dates, etc. Some changes in age of ewes, breeding and weaning dates, etc. occur from year to year.

Lamb production was slightly below average in 1953 for Rambouillet and Targhee inbred lines when compared to other years, exclusive of 1952 when vibriosis occurred. However, production was above average for the Columbia lines.

Lamb production as evaluated by pounds of lamb per ewe bred was well above average in 1954 for all three breeds.

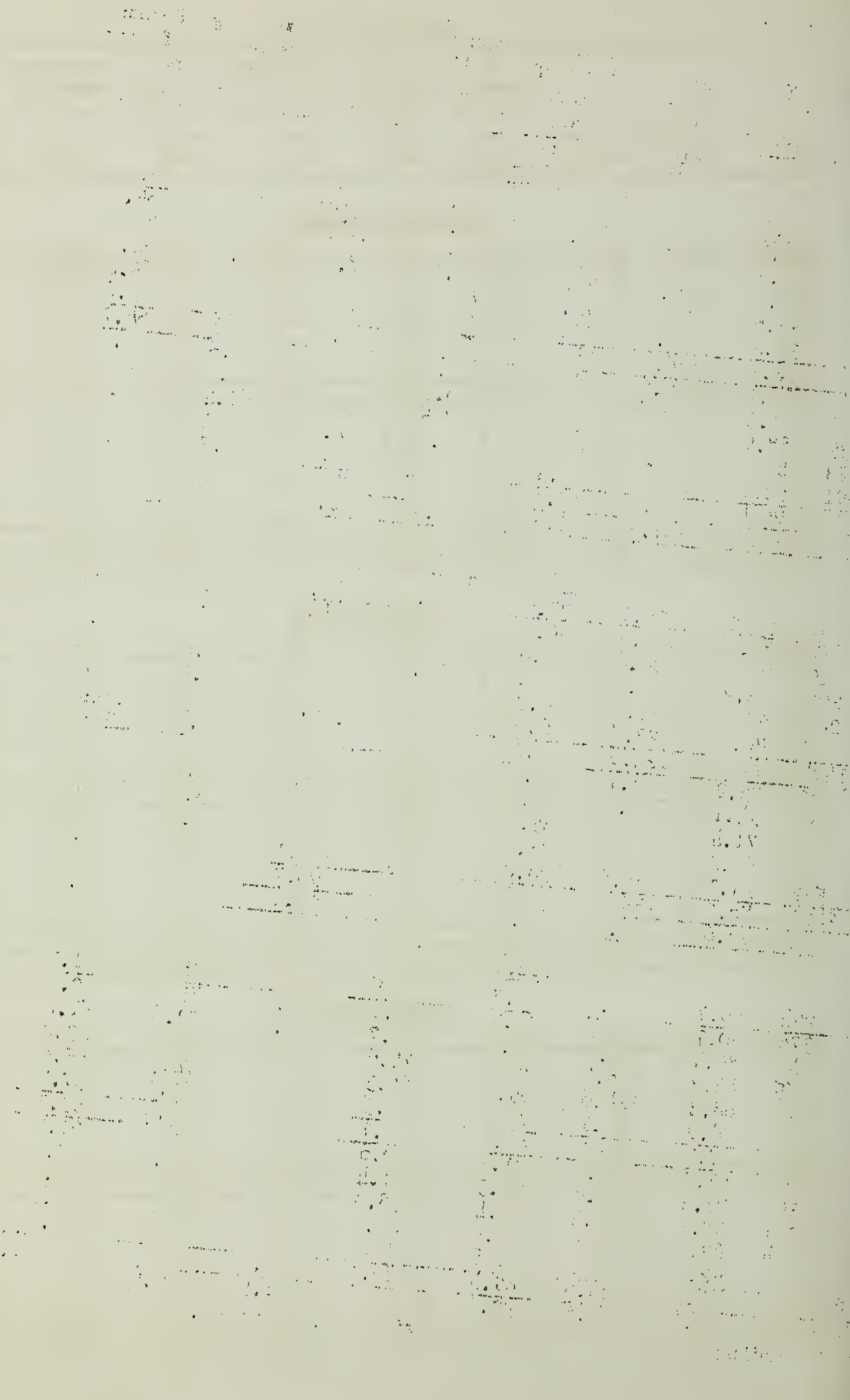
The Columbia inbred lines have tended to improve more in lamb production in the last five-year period than have the inbred lines from either of the other two breeds. Part of this more rapid improvement may be related to a more pronounced decline for Columbias in the previous five-year period. The Targhees have exhibited the most notable improvement considering both periods.

The varying changes in lamb production for the three breeds since 1944 may be associated to some extent with increases in inbreeding. Rambouillet dams increased approximately 11% in inbreeding from 1944 to 1954. Columbia dams increased only 6% during the same period, and Targhee dams increased the least, only 4%.

LAMB PRODUCTION

Year	No. of ewes bred	% of ewes lambing	% lambs born of ewes lambing	% live lambs born of lambs born	% lambs weaned of live lambs born	% lambs weaned of ewes bred	Average weaning weight in pounds	Pounds of lamb per ewe bred
Rambouillet Lines								
1940-44	4489	90.6	127.6	92.9	86.6	91.9	77.7	71.4
1945	898	92.7	124.0	94.4	87.4	93.5	69.5	65.0
1946	890	94.3	134.5	94.6	86.4	100.7	70.8	71.4
1947	897	90.0	124.1	94.6	86.2	88.3	70.6	62.4
1948	882	93.6	130.7	94.9	86.2	98.8	66.3	65.4
1949	1002	90.4	128.4	93.2	81.1	86.1	69.5	59.8
1945-49	4569	92.2	128.0	94.3	85.4	93.3	69.3	64.7
1950	851	89.1	119.6	94.5	79.6	76.0	70.5	53.6
1951	806	91.3	133.8	94.2	78.7	89.3	72.0	64.3
1952	739	88.9	123.1	68.2	77.5	56.8	67.4	38.3
1953	723	89.8	134.2	91.7	79.7	84.9	72.1	61.2
1954	691	93.1	139.5	92.3	81.9	96.1	70.7	68.0
1950-54	3810	90.4	129.8	88.6	79.6	80.4	70.8	56.9
1950-54*	3071	90.7	131.2	93.3	79.9	86.1	71.3	61.4
TARGHEE LINES								
1941-44	800	92.2	128.7	93.6	78.9	86.5	72.6	62.8
1945	257	88.4	127.9	96.1	84.4	84.4	71.7	60.5
1946	245	95.8	130.6	96.0	76.3	89.4	72.1	64.4
1947	299	93.2	118.9	91.4	78.6	78.6	74.6	58.6
1948	288	92.2	127.1	90.7	83.1	87.2	72.5	63.2
1949	408	88.6	122.5	96.0	81.8	82.8	77.6	64.3
1945-49	1497	91.4	124.9	94.1	80.0	84.2	74.0	62.3
1950	420	95.2	128.1	92.5	85.0	94.8	73.8	70.0
1951	434	94.1	140.8	95.4	86.2	106.7	74.5	79.5
1952	476	71.4	124.5	65.6	86.1	48.3	73.2	35.4
1953	559	88.2	142.6	93.5	82.3	95.9	72.9	69.9
1954	532	94.1	138.8	96.0	86.9	107.1	78.1	83.7
1950-54	2421	88.5	135.8	90.3	85.2	90.7	74.8	67.9
1950-54*	1945	92.6	138.0	94.4	85.0	101.1	74.9	75.8
COLUMBIA LINES								
1941-44	1294	86.7	126.0	90.7	80.5	78.0	78.5	61.3
1945	378	90.7	128.5	93.5	78.5	83.1	73.0	60.6
1946	448	89.4	130.9	90.6	68.7	70.5	72.6	51.2
1947	455	82.7	118.7	79.6	74.6	56.9	76.0	43.2
1948	320	88.3	124.6	85.7	80.3	75.0	74.3	55.8
1949	381	88.9	126.1	90.1	73.5	72.2	80.0	57.7
1945-49	1982	87.8	125.9	88.0	74.7	70.8	75.0	53.2
1950	343	87.2	127.7	91.2	80.6	79.9	76.6	61.2
1951	355	93.3	136.6	94.3	81.4	95.2	76.4	72.7
1952	331	68.2	124.4	69.4	78.0	45.0	73.0	32.9
1953	344	89.4	146.0	93.5	81.7	98.6	73.1	72.1
1954	312	92.3	139.9	91.8	78.5	92.3	80.4	74.2
1950-54	1685	86.2	135.6	89.4	80.3	82.4	76.1	62.7
1950-54*	1354	90.5	137.5	92.7	80.6	91.5	76.5	70.0

* Excluding 1952, the year in which vibriosis occurred.



REPRODUCTIVE PHYSIOLOGY

Ram Semen Tests for 1952

No ram lambs were tested in 1952 because it was desired to obtain data on the semen characteristics of all yearling rams, both those intended for use in breeding and those held as "reserves". As usual the only mature rams tested were those intended for use in breeding. Data on the semen characteristics of mature rams are of questionable value for analytical purposes because of the bias resulting from the previous culling of rams with poor semen or poor breeding records. Therefore, semen tests on mature rams are of little experimental value but do serve to identify those rams whose semen indicates that they are of questionable fertility and are, therefore, poor breeding risks.

The semen of 240 rams was examined before the beginning of the breeding season. The table on the next page shows that 186 or 77.5 percent had semen of acceptable quality after the first test, while 54 rams or 22.5 percent had semen ranging from borderline to definitely poor quality. Forty-seven rams were retested after which 21 were considered to be potentially fertile and 26 were considered to be poor breeding risks. The other 7 rams were not retested because they were not needed for use in breeding. Fourteen other rams refused to serve under test conditions and 2 rams were unable to copulate normally. None of these rams were used in breeding.

On the basis of all rams tried, 50.0% of the 60 rams 2 years of age and older had semen of acceptable quality, 43.3% had semen of borderline to poor quality and 6.7% refused or were unable to serve, Corresponding figures for 196 yearlings were 79.6%, 14.3% and 6.1%.

One hundred and eleven of these rams were used in breeding. The following table shows that all rams except one settled 60 percent or more of their ewes, 89 percent settled 80 percent or more and 26 percent settled all of their ewes.

Distribution of Percentages of Ewes Lambing in 1953

Breed		Pens having a Percentage of Ewes Lambing of:							
		0	1-19	20-39	40-59	60-79	80-99	100	Total
Ramb.	No. of Pens	0	0	0	0	8	34	16	58
	Percent of Pens	0	0	0	0	14	59	28	
Targ.	No. of Pens	0	1	0	0	1	21	13	36
	Percent of Pens	0	3	0	0	3	58	36	
Col.	No. of Pens	0	0	0	0	2	15	0	17
	Percent of Pens	0	0	0	0	12	88	0	
All	No. of Pens	0	1	0	0	11	70	29	111
	Percent of Pens	0	1	0	0	10	63	26	

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Summary of Ram Semen Tests - 1952

					First Test					Second Test				
						Rams having semen of:					Rams having semen of:			
			Number refusing to serve			Acceptable quality		Borderline to poor quality			Acceptable quality		Borderline to poor quality	
Breed	Age	No. of rams tried	No.	%	Number tested	No.	%	No.	%	Number tested	No.	%	No.	%
Ramb.	3 or over	8	0	0.0	8	4	50.0	4	50.0	3	1	33.3	2	66.7
	2	20	1	5.0	19	11	57.9	8	42.1	8	2	25.0	6	75.0
	1	97	6	6.2	91	82	90.1	9	9.9	6	4	66.7	2	33.3
TOTAL ALL		124	7	5.6	118	97	82.2	21	17.8	17	7	41.2	10	58.8
Targ.	3 or over	3	0	0.0	3	1	33.3	2	66.7	2	1	50.0	1	50.0
	2	20	3	15.0	17	8	47.1	9	52.9	9	3	33.3	6	66.7
	1	63	3	4.8	60	47	78.3	13	21.7	12	8	66.7	4	33.3
TOTAL ALL		86	6	7.0	80	56	70.0	24	30.0	23	12	52.2	11	47.8
Col.	3	1	0	0.0	1	0	0.0	1	100.0	1	0	0.0	1	100.0
	2	8	0	0.0	8	6	75.0	2	25.0	2	0	0.0	2	100.0
	1	36	3	8.3	33	27	81.8	6	18.2	5	2	40.0	3	60.0
TOTAL ALL		45	3	6.7	42	33	78.6	9	21.4	7	2	28.6	5	71.4
ALL	3 or over	12	0	0.0	12	5	41.7	7	58.3	6	2	33.3	4	66.7
	2	48	4	8.3	44	25	56.8	19	43.2	19	5	26.3	14	73.7
	1	196	12*	6.1	184	156	84.8	28	15.2	23	14	60.9	9	39.1
GRAND TOTAL		256	16*	6.2	240	186	77.5	54	22.5	47	21	44.7	26	55.3

* Includes 2 rams that were unable to copulate normally.

Ram Semen Tests for 1953

All yearling rams were tested in 1953 whether or not they were intended for use in breeding in order to obtain data on semen production. As usual, the only mature rams and ram lambs tested were those intended for possible use in breeding.

The semen of 242 rams was examined before breeding. The table on the following page shows that 140 or 58 percent had semen of acceptable quality after the first test while 102 or 42 percent had semen considered to be of borderline to definitely poor quality. Fifty-eight rams were retested. Of these, 20 or 34 percent had semen of acceptable quality while 38 or 66 percent were considered to be poor breeding risks. Seventeen of 234 rams 1 year of age or older and 20 of 45 ram lambs refused to serve under test conditions. None of the rams that refused to serve were used in breeding.

On the basis of all rams tried, 52 percent of 159 yearling rams had semen of acceptable quality on first test, 37 percent had semen of borderline to definitely poor quality and 11 percent refused to serve. Corresponding percentages for 75 rams 2 years old or older and for 45 ram lambs, respectively, were 70, 30 and 0 and 9, 47 and 44.

The percentage of rams with semen considered to be acceptable quality has been decreasing steadily the past few years. It seems likely that this is not so much a reflection of an actual decrease in semen quality as a reflection of higher standards used in evaluating the semen. It is known, for example, that more emphasis has been placed on sperm morphology in recent years.

One hundred and twenty two rams were used in breeding. The following table shows that all rams settled at least 60 percent of the ewes to which they were bred, 69 percent settled 80 percent or more and 29 percent settled all of their ewes.

Distribution of Percentages of Ewes Lambing in 1954

Breed		Pens Having a Percentage of Ewes Lambing of: 0	1-19	20-39	40-59	60-79	80-99	100	Total
Ramb.	No. of Pens	0	0	0	0	3	41	21	65
	Percent of Pens	0	0	0	0	5	63	32	
Targ.	No. of Pens	0	0	0	0	0	23	13	36
	Percent of Pens	0	0	0	0	0	64	36	
Col.	No. of Pens	0	0	0	0	0	20	1	21
	Percent of Pens	0	0	0	0	0	95	5	
All	No. of Pens	0	0	0	0	3	84	35	122
	Percent of Pens	0	0	0	0	2	69	29	

Summary of Semen Tests - 1953

					First Test					Second Test				
						Rams having semen of:					Rams having semen of:			
		No. of rams tried	Rams refusing to serve		No. rams tested	Acceptable quality		Borderline to definitely poor quality		No. rams tested	Acceptable quality		Borderline to definitely poor quality	
Breed	Age		No.	%		No.	%	No.	%		No.	%	No.	%
Ramb.	3 or over	6	0	0	6	4	67	2	33	1	1	100	0	0
	2	30	0	0	30	25	83	5	17	3	2	67	1	33
	1	88	9	10	79	49	62	30	38	23	10	43	13	57
	Lamb	20	7	35	13	3	23	10	77	2	1	50	1	50
Total all		144	16	11	128	81	63	47	37	29	14	48	15	52
Targ.	3 or over	2	0	--	2	1	50	1	50	1	0	0	1	100
	2	21	0	--	21	13	62	8	38	8	1	12	7	88
	1	47	3	6	44	22	50	22	50	8	2	25	6	75
	Lamb	15	8	53	7	0	0	7	100	1	0	0	1	100
Total all		85	11	13	74	36	49	38	51	18	3	17	15	83
Col.	3 or over	3	0	--	3	2	67	1	33	1	0	0	1	100
	2	13	0	--	13	8	62	5	38	4	0	0	4	100
	1	24	5	21	19	12	63	7	37	6	3	50	3	50
	Lamb	10	5	50	5	1	20	4	80	0	--	--	--	--
Total all		50	10	20	40	23	58	17	42	11	3	27	8	73
All	3 or over	11	0	0	11	7	64	4	36	3	1	33	2	67
	2	64	0	0	64	46	72	18	28	15	3	20	12	80
	1	159	17	11	142	83	58	59	42	37	15	41	22	59
	Lamb	45	20	44	25	4	16	21	84	3	1	33	2	67
Grand Total		279	37	13	242	140	58	102	42	58	20	34	38	66

Causes of Reproductive Failure in 2-Year-Dry Range Ewes

This study was initiated in 1953 to determine the nature and causes of reproductive failure in ewes that had failed to lamb for 2 consecutive years. The Station ewes studied had been exposed to rams known to be fertile, for about 30 days (pen breeding) each year; and in addition, part of them had been subsequently exposed to rams whose semen was judged to be of reasonably high quality, for an additional period of 10-14 days in range breeding. In 1954, ewes that had been handled similarly were obtained from the Montana Agricultural Experiment Station for inclusion in the study.

Each fall the Station 2-year-dry ewes were removed from the flock at culling time, about September 20. At the same time another group of ewes of similar ages and breeding that had been removed from the flock for reasons other than poor reproduction (mostly ewes with unsound udders) were sorted out and placed with the "drys" to serve as controls. Ewes obtained from Montana were handled similarly, i.e. Montana "drys" were paired with Montana "Controls". All ewes were then pasture bred for a period of 18 days. The allotment of ewes was about 10 ewes per ram. The ewes were slaughtered in a packing plant at Ogden, Utah (Swift and Company) about 30 days after the rams were removed, i.e. 30 to 48 days after breeding. The autopsy findings are presented in the following table:

Year	Kind of ewes	No. of ewes	Pregnant		Non-pregnant	
			Normal	Abnormal*	Normal	Abnormal
1953	2-year drys	19	11	1	5	2
	Controls	10	10	0	0	0
1954	2-year drys	29	11	6	8	4
	Controls	22	18	1	3	0
All	2-year drys	48	22	7	13	6
	Controls	32	28	1	3	0

* Ewes in this group had abnormal embryos at time of slaughter ranging from hemorrhagic embryos to dead embryos in rather advanced stages of degeneration.

The high percentage of pregnancies in the control group indicates not only that the rams used in these experiments were highly fertile but also that normal ewes were likewise highly fertile at this time of the year. Therefore, the relatively low percentage of normal pregnancies in the "dry" ewes must be attributed to other causes. The data indicate that embryonic death and gross genital abnormalities are both involved but the numbers are too small to evaluate the relative importance of these factors. The low percentage of pregnant ewes in the "dry" group, even in the early stages of gestation, indicates that the culling of such ewes is a good management practice. This study is being continued with both Station ewes and Montana ewes.

The Effect of Year, Breed, Age and Number of Ewes Bred on Fertility in Range Rams

The effect of year, breed, age and number of ewes bred on the fertility of 1109 rams bred to 31,473 ewes over the 15-year period 1936 to 1950, inclusive, was studied.

The overall 15-year average percentage of ewes lambing was 90.7. The yearly percentages ranged from a low of 87.9 in 1946 to a high of 93.7 in 1950. There did not appear to be any definite trend in fertility over the period of study. Unweighted means of percentages of ewes lambing by 5-year periods were 90.87, 90.62 and 90.68 for the first, second and third periods, respectively. Thus it appears that if any factors were operating to cause a long-time upward trend in fertility (e.g. improvements in management and/or nutrition) they were opposed by other factors that tended to cause decreases in fertility of about the same magnitude.

Rams of the Rambouillet and Columbia breeds were used in each of the 15 years. Targhee rams were used every year except 1938 and Corriedale rams were used in each of the 9 years 1936-1944, inclusive. A total of 11 rams of 3 other breeds was used in 6 different years. Because of the small number of rams in any one breed, these 11 rams have been considered as one group. Targhee rams had the highest average percentage of ewes lambing followed in order by Corriedales, Rambouillets, Columbias and rams of the miscellaneous group. When Rambouillets, Targhees and Columbias were compared in each of the 14 years that all 3 breeds were represented, Targhee rams were highest in fertility in 9 years, intermediate in 3 years and lowest in only 2 years. In the same manner Rambouillets were highest in fertility in 3 years, intermediate in 6 years and lowest in 5 years. Corresponding figures for Columbias were 2, 5 and 7. When Corriedales were compared to Rambouillets, Targhees and Columbias in each of 8 years that all 4 breeds were represented they were found to rank first in fertility in 2 years, second in 3 years, third in one year and last in 2 years. The 11 rams of the miscellaneous breeds were quite low in fertility but it is emphasized that the semen of several of these rams was known to be of poor quality at the time they were used. Had they not been purchased for a particular purpose in the breeding program or if "reserve rams" had been available, several of the rams would not have been used because they were considered to be poor breeding risks. It is emphasized that these data on the relative fertility of different breeds of rams have several limitations. Probably the most important limitation is that, with the exception of the 11 rams of the "miscellaneous" breeds, most of the rams were mated to ewes of their own breed. Therefore, the breed comparisons of fertility are not necessarily comparisons of fertility of different breeds of rams but rather of the overall breed fertility as affected by fertility of both rams and ewes under conditions prevailing at this Station.

Rams 4 years old and older had the highest percentage of ewes lambing and were followed in order by 2-year olds, yearlings, lambs and 3-year olds as shown by the second table. A year-by-year comparison of fertility of

Effect of Year and Breed on Fertility in Range Rams

Breed	1936		1937		1938		1939		1940		1941		1942		1943	
	No.	%*	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ramb.	3	88.0	31	92.6	43	89.7	64	88.7	64	90.6	56	88.9	55	83.9	46	88.2
Targ.	1	100.0	2	98.0	0	----	5	95.0	8	93.9	10	92.9	8	92.6	12	92.9
Col.	3	93.3	4	88.5	2	88.0	12	93.2	16	90.8	15	92.1	14	85.8	20	93.3
Corr.	2	94.5	2	97.0	2	100.0	4	97.0	4	80.0	5	94.4	4	91.8	4	89.2
Misc.**	0	---	3	78.7	1	67.0	0	---	0	---	0	---	0	---	0	---
All	9	92.6	42	91.7	48	89.6	85	90.1	92	90.5	86	90.2	81	88.9	82	90.2

Breed	1944		1945		1946		1947		1948		1949		1950		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ramb.	52	93.0	33	93.4	37	89.8	39	93.4	37	90.3	48	89.4	58	93.8	666	90.6
Targ.	9	91.9	11	92.0	18	94.3	22	91.3	25	83.6	25	25.9	32	95.2	188	92.5
Col.	23	91.1	16	86.6	17	83.2	19	92.7	15	91.3	19	87.5	18	90.7	213	89.9
Corr.	4	87.8	0	---	0	---	0	---	0	---	0	---	0	---	31	91.6
Misc.**	0	---	1	97.0	4	60.8	1	97.0	1	93.0	0	---	0	---	11	75.7
All	88	92.1	61	91.7	76	87.9	81	92.7	78	88.4	92	90.8	108	93.7	1109	90.7

* Average percentage of ewes lambing per ram.

** This group consisted of 7 Merinos, 3 Lincolns and 1 Border Leicester.

Effect of Age and Number of Ewes Bred on Fertility in Range Rams

	Number of Ewes Per Ram															
	5-10		10-19		20-29		30-39		40-49		50-59		60-65		Total	
Age	No rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.	No. rams	Ave. % preg.
Lambs	2	94.0	22	92.8	85	87.5	24	90.6	1	98.0	1	90.0	0	--	135	89.1
1 yr.	14	87.3	54	94.2	262	90.6	122	90.1	43	92.9	19	89.8	2	92.5	516	90.9
2 yr.	2	100.0	14	88.5	97	91.1	62	92.7	21	91.2	7	89.9	1	87.0	209	91.4
3 yr.	1	100.0	11	88.3	52	87.4	29	90.4	22	90.4	6	93.3	4	86.0	125	89.0
4 & over	0	--	8	91.6	59	92.4	33	92.3	13	93.1	9	85.1	2	88.0	124	91.8
All	19	90.0	114	92.3	555	90.1	270	91.0	100	92.1	42	89.3	9	88.0	1109	90.7

rams of different ages was made and with the exception that 2-year-old rams were never lower than third in fertility, there was no apparent consistency in the "rank" of rams of different age groups over the 15-year period. This is consistent with earlier results. Thus it appears that there are no really important differences in fertility of rams of different ages under the system of management followed at this Station.

The number of ewes bred to a single ram during a breeding season of approximately 30 days ranged from 5 to 65. For study, the pens of different sizes were grouped in multiples of 10 ewes, i.e. less than 10, 10-19, 20-29 ewes, etc. The average percentage of ewes lambing in the 2 groups containing 50 or more ewes per pen was slightly lower than any of the pen groups of smaller number of ewes. There was no trend in fertility with increasing numbers of ewes up to 50. Thus it appears that individual rams whose semen is known to be of good quality at the beginning of the breeding season can be bred to at least 50 ewes in a 30-day breeding season without a reduction in the percentage of ewes lambing. The reduction in fertility appears to be slight when as many as 65 ewes are bred to a single ram.

Estrus in Ewe Lambs

Earlier studies at this Station have shown that the reproductive performance of 2-year-old ewes is correlated with subsequent performance. However, 2-year-old production is not very useful in selecting ewes for a potentially high reproductive performance because under the current system of management it becomes available only after most of the selection of a given generation of females has already taken place. It is doubtful that it would ever be practical to defer culling until 2-year-old lamb production records were available on all females. Therefore, if more intensive selection for higher reproductive performance is to be made, it will be necessary to develop measures of potential reproductive capacity that are available relatively early in the animal's life, i.e. before the first major culling takes place.

In 1952, a study was initiated to obtain information on the sexual activity of ewe lambs (during their first winter) and its relationship to subsequent reproductive performance. The procedure has been to run vasectomized rams (at the rate of 3 rams per 100 ewe lambs), equipped with marking harnesses, with the lambs from the time they are separated from their mothers in late September until shearing time the following May. At bi-weekly intervals the flock is checked and the eartag numbers of the marked lambs are recorded. Thus the date of the first heat can be determined within reasonable limits. By clipping off the crayon marks and changing the colors of the marking crayons, the total number of heat periods the lamb experienced during the winter can be determined.

The following table shows that 15.9 percent of 573 ewe lambs born in 1952 and 14.5 percent of 891 ewe lambs born in 1953 had one or more heat periods during their first winter:

Percent of Ewe Lambs in Heat During Their First Winter

Year of birth	Breed	Total lambs	Number in heat	Percent in heat
1952	Rambouillet	296	54	18.2
	Targhee	172	25	14.5
	Columbia	105	12	11.4
	All	573	91	15.9
1953	Rambouillet	412	62	15.0
	Targhee	296	47	15.9
	Columbia	183	20	10.9
	All	891	129	14.5

In both years the lambs that came into heat were less inbred than those that failed to come into heat and also had less face covering, better condition scores and heavier body weights at weanling and yearling ages.

The following table shows that the ewes that came into heat as lambs had better 2-year-old lamb production records than those that failed to come into heat in the Rambouillet and Targhee breeds but not in Columbias. However, there were only 9 ewes in the "in heat" group in Columbias.

Comparison of 2-Year-Old Lamb Production (1954) of Ewes in Heat and Not in Heat Their First Winter

	Rambouillet		Targhee		Columbia	
Item	Heat	No heat	Heat	No heat	Heat	No heat
No. ewes at lambing	40	173	25	132	9	83
% dry ewes	2.5	8.7	5.0	10.6	33.3	15.7
% lambs per ewes at lambing	107	95	112	102	67	86
Average lambing date	14	13	25	23	28	26
Average milk score	3.3	3.4	3.6	3.8	3.8	3.8
% lambs weaned	83	78	92	87	56	63
Ave. weaning weight	69	71	78	76	77	78
Pounds lamb weaned per ewe at lambing	60	48	68	66	43	49

The Effect of Vibriosis Upon Subsequent Reproduction in Range Ewes

It is generally believed that individual flocks of range sheep seldom, if ever, suffer losses from vibrionic abortion in consecutive years. However, there appears to be little or no information regarding the effect of vibriosis on the percentage of non-pregnant (dry) ewes, the percentage of multiple births, and other expressions of fertility in a flock in subsequent years. This study was made to secure such information. A detailed account of the losses from vibriosis in the spring of 1952 were given in a previous annual report.

At culling time in 1952, ewes were eliminated as usual for old age, unsoundness, etc., but no special effort was made to eliminate or retain ewes that had immature lambs the previous spring. Likewise, in selecting rams for use in breeding, no attempt was made to use or avoid using rams simply because they had been used the year before. As a result, 21 rams used the fall before the vibriosis outbreak were used again the following fall.

Data were available on the lamb production of 1,768 ewes that were in the flock in 1952 and 1953 and were bred in pens in which there was no evidence of low fertility in the rams used. The sample of ewes studied was representative of the entire flock in 1952 in percentage of dry ewes and ewes having immature lambs. Data were also available on the 1953 lamb production of 692 2-year-old ewes that were added to the breeding flock the fall after the outbreak of vibriosis.

To compare lamb production in the two years, individual ewe within breed and age groups (e.g., Columbia ewes born in 1945) were placed in one of four classifications on the basis of their 1952 lambing records, namely: dry (no lambs born), immature lamb(s), dead lamb(s), or live lamb(s). The ewes within each class were similarly classified on the basis of their 1953 lambing records except that ewes having live lambs were divided further into those having 1 live lamb and those having 2 or more live lambs.

The percentages of ewes having immature lambs in 1953 were much lower than in 1952 in every breed and age group studied. In 1953 the percentages were 2.8 for ewes 3 years old and older, i.e., ewes that had been in the flock the year of the vibriosis outbreak, and 3.2 for the 2-year-old ewes. Both percentages were slightly below the average percentage (3.5) of ewes of all ages having immature lambs in this flock from 1940 through 1951. Thus, the percentage of ewes having immature lambs was no higher than normal the year following a bad outbreak of vibriosis either in the ewes retained or in replacement ewes added to the breeding flock.

The percentage of dry ewes was much lower in 1953 than in 1952 in practically every age group within the Columbia and Targhee breeds. Over-all percentages of dry ewes were 29.0 and 9.0 in Columbias and 23.7 and 6.4 in Targhees in 1952 and 1953, respectively. The 1953 figures are about 2 percent lower in Columbias and 1 percent lower in Targhees than the long-time average percentages for these breeds. The percentage of dry ewes in Rambouillets was 8.0 in 1953 as compared with 6.4 in 1952 and a long-time average percentage of 9.4.

Percentages of Ewes Having Immature Lambs in 1952 and 1953
(Dry pens excluded)

Breed*	Year of lambing	Population	No. ewes	Age of ewes in years						
				2	3	4	5	6	7	8
				(%)	(%)	(%)	(%)	(%)	(%)	(%)
Columbia	1952	All	524	31	23	20	21	6	14	26
	1952	Sample**	379	32	24	22	22	1	27	--***
	1953	All	531	4	4	1	3	0	0	0
Targhee	1952	All	676	24	31	28	27	18	7	20
	1952	Sample**	498	27	37	25	31	19	4	--***
	1953	All	739	4	0	1	1	4	0	9
Rambouillet	1952	All	1252	31	31	28	24	18	12	10
	1952	Sample**	891	30	33	31	28	14	11	--***
	1953	All	1190	2	7	5	1	3	0	0

* Columbia and Targhee ewes were bred 18 days later than Rambouillet ewes for 1952 lambing.

** The ewes in this group were also present at lambing in 1953 and were included in the study reported here.

*** Only a few ewes that were 8 years old in 1952 were still in the flock in 1953, and they were combined with the 7-year-old ewes in this study.

The data on lamb production in the three breeds could not be summarized satisfactorily because previous analyses had established that ewes with different kinds of 1952 lambing records (dry ewes, ewes having immature lambs, etc.) were not present in equal proportions in different breeds or in different age groups within breeds as shown in the preceding and following tables. It is obvious that if the 1953 lamb production by ewes with different kinds of 1952 lambing records was compared over all ages within a breed, possible differences in production associated with previous lambing records would be confounded with differences in production caused by differences in the ages of the ewes. Similarly, comparisons within age groups over all breeds would be confounded with breed differences in lamb production. Therefore the detailed data are shown in the next three tables.

Within breed and age groups, ewes with the four kinds of 1952 lambing records did not differ significantly in their 1953 lamb production as evaluated by the following criteria: percentage of dry ewes, percentage of ewes having immature lambs, percentage of ewes having dead lambs, percentage of ewes having 1 live lamb, percentage of ewes having 2 or more live lambs, percentage of live lambs born per ewe at lambing, percentage of lambs weaned per ewe, or percentage of live lambs born. The weaning weights of the lambs were not analyzed statistically; but in view of the great variation in the weights of individual lambs, the relatively

small numbers of lambs within groups, and the apparent lack of consistency from one breed and age group to another, it did not appear that significant differences in weaning weights of lambs could be detected in these data.

Over-all lamb production in 1953 as measured by the percentage of ewes lambing, percentage of live lambs of all lambs born, percentage of lambs weaned of live lambs born, and average weaning weight of lambs appeared to be slightly above average. This was probably due to a favorable year rather than to any beneficial effect of vibriosis on lamb production the following year.

Percentages of Dry Ewes in 1952 and 1953 (Dry Pens Excluded).

Breed*	Year of lambing	Population	No. ewes	Age of ewes in years						
				2	3	4	5	6	7	8
				(%)	(%)	(%)	(%)	(%)	(%)	(%)
Columbia	1952	All	524	29	40	22	27	19	11	10
	1952	Sample**	379	27	37	18	25	16	0	--***
	1953	All	531	17	9	8	0	7	0	7
Targhee	1952	All	676	29	14	21	27	8	2	7
	1952	Sample**	498	26	7	21	22	6	0	--***
	1953	All	739	10	4	1	6	4	10	4
Rambouillet	1952	All	1252	9	7	6	8	2	2	10
	1952	Sample**	891	4	6	10	6	8	13	--***
	1953	All	1190	12	6	4	9	9	7	4

* The higher percentage of dry ewes in the Columbia and Targhee breeds in 1952 may have been the result of more prenatal death and resorption, since these breeds were bred 18 days later than the Rambouillets.

** The ewes in this group were also present at lambing in 1953 and were included in the study reported here.

*** Only a few ewes that were 8 years old in 1952 were still in the flock in 1953 and they were combined with the 7-year-old ewes in this study.

It seems reasonable that two possible effects of vibriosis on subsequent reproductive performance of ewes in this flock might be expected. It could be assumed that the high percentage of ewes that did not nurse lambs in 1952 would benefit from the rest and would consequently "rebound" in production in 1953 to the extent that the over-all lamb production of the flock would be definitely above average. On the other hand, it could be argued that a considerable number of the ewes that aborted or resorbed their fetuses probably sustained permanent injuries to their genital tracts or to their general health, or to both, that would seriously interfere with their production in subsequent years. The advanced stages of degeneration of some fetuses at time of expulsion, the purulent discharges

of some ewes for some time after parturition and the fact that death losses of ewes at lambing seemed higher than normal could be cited as reasons for thinking that vibrionic infection would permanently injure some ewes. Since there were no significant differences in the 1953 lamb production of ewes with different kinds of 1952 lambing records, it could be argued that the vibrionic infection in 1952 simply had no long-lasting effects on any of the ewes. However, it seems much more reasonable to assume that both of the effects mentioned previously were operating but that they tended to cancel each other. In other words, some ewes did indeed "rebound" in production after a year of rest but other ewes failed to produce as they would have had their genital tracts not been injured as a consequence of vibriosis. A careful study of a large body of data would probably yield some information on this point but the present data are inadequate for the purpose.

These results indicate that in the year following an outbreak of vibriosis the over-all production of ewes that aborted or were dry was about the same as that of ewes of the same breed and age that reproduced normally during the year of the infection. Therefore, in the event of an outbreak of vibriosis in a flock, it would seem wise to cull the ewes in the usual manner for unsoundness, old age, etc., and not make any special effort to either discard or retain ewes solely on the basis of their lambing record in that year. However, it is emphasized that the results reported here may not be entirely consistent with the results that would be expected in other flocks under different systems of management or even in this flock at another time.

Reproductive Performance of Columbia Ewes in 1952 and 1953

			1953 Lamb Production*								
			Percentage of ewes having:					%	%		Pounds
Ewe's year birth	1952 lambing record	No. ewes	No lambs	Imm. lambs	Dead lambs	One live lamb	Two live lambs	live lambs born per ewe	lambs weaned per ewe	Ave. wng. wt.	lamb weaned per ewe
1945 or before	No lambs	0	--	--	--	--	--	--	--	--	--
	Imm "	4	0.0	0.0	0.0	75.0	25.0	125.0	100.0	83.0	83.0
	Dead "	0	--	--	--	--	--	--	--	--	--
	Live "	11	9.1	0.0	9.1	27.3	54.5	136.4	118.2	66.2	78.3
	All	15	6.7	0.0	6.7	40.0	46.7	133.3	113.3	70.2	79.5
1946	No lambs	5	0.0	0.0	0.0	40.0	60.0	160.0	100.0	88.0	88.0
	Imm. "	1	0.0	0.0	0.0	0.0	100.0	200.0	200.0	65.5	131.0
	Dead "	1	0.0	0.0	0.0	100.0	0.0	100.0	100.0	74.0	74.0
	Live "	25	0.0	0.0	0.0	52.0	48.0	148.0	112.0	76.1	85.2
	All	32	0.0	0.0	0.0	50.0	50.0	150.0	112.5	77.1	86.8
1947	No lambs	15	6.7	0.0	0.0	33.3	60.0	153.3	120.0	76.2	91.4
	Imm. "	13	7.7	0.0	0.0	15.4	76.9	169.2	153.8	75.8	116.7
	Dead "	2	0.0	0.0	0.0	50.0	50.0	150.0	150.0	78.7	118.0
	Live "	29	6.9	0.0	0.0	37.9	55.2	148.3	137.9	74.2	102.3
	All	59	6.8	0.0	0.0	32.2	61.0	154.2	137.3	75.2	103.2
1948	No lambs	13	0.0	0.0	0.0	46.2	53.8	153.8	146.2	77.8	113.8
	Imm. "	16	0.0	0.0	6.2	37.5	56.2	150.0	100.0	82.8	82.8
	Dead "	1	0.0	0.0	0.0	100.0	0.0	100.0	0.0	--	0.0
	Live "	44	0.0	4.5	2.3	38.6	54.5	147.7	127.3	74.8	95.2
	All	74	0.0	2.7	2.7	40.5	54.1	148.6	123.0	76.8	94.5
1949	No lambs	28	7.1	3.6	10.7	46.4	32.1	110.7	75.0	78.7	59.0
	Imm. "	18	11.1	0.0	0.0	33.3	55.6	144.4	94.4	81.3	76.8
	Dead "	2	0.0	0.0	0.0	100.0	0.0	100.0	100.0	90.5	90.5
	Live "	28	7.1	0.0	0.0	35.7	57.1	153.6	142.9	77.2	110.4
	All	76	7.9	1.3	3.9	40.8	46.1	135.2	105.3	78.8	83.0
1950	No lambs	33	12.1	6.1	0.0	57.6	24.2	106.1	81.8	79.3	64.9
	Imm. "	39	5.1	5.1	5.1	35.9	48.7	133.3	97.4	74.7	72.8
	Dead "	3	33.3	0.0	0.0	66.7	0.0	66.7	66.7	88.0	58.7
	Live "	48	8.3	2.1	4.2	50.0	38.6	120.8	108.3	76.3	82.6
	All	123	8.9	4.1	3.3	48.0	35.8	119.5	96.7	76.7	74.2

*All percentages are calculated on the basis of ewes present at lambing.

Reproductive Performance of Targhee Ewes in 1952 and 1953

			1953 Lamb Production*								
			Percentage of ewes having:					% live lambs born per ewe	% lambs weaned per ewe	Ave. wng. wt.	Pounds lamb weaned per ewe
Ewe's year birth	1952 lambing record	No. ewes	No lambs	Imm. lambs	Dead lambs	One live lamb	Two live lambs				
1945 or before	No lambs	0	--	--	--	--	--	--	--	--	--
	Imm. "	1	0.0	0.0	0.0	0.0	100.0	200.0	200.0	90.5	181.0
	Dead "	0	--	--	--	--	--	--	--	--	--
	Live "	22	4.5	9.1	0.0	31.8	54.5	150.0	90.9	74.8	68.0
	All	23	4.3	8.7	0.0	30.4	56.5	152.2	95.7	76.3	73.0
1946	No lambs	4	0.0	0.0	0.0	25.0	75.0	175.0	175.0	79.0	138.2
	Imm. "	12	16.7	0.0	0.0	25.0	58.3	150.0	141.7	77.1	109.2
	Dead "	0	--	--	--	--	--	--	--	--	--
	Live "	47	8.5	0.0	0.0	38.3	53.2	144.7	123.4	73.4	90.6
	All	63	9.5	0.0	0.0	34.9	55.6	147.6	130.2	74.6	97.2
1947	No lambs	18	0.0	0.0	0.0	27.8	72.2	172.2	150.0	72.3	108.5
	Imm. "	26	3.8	7.7	0.0	38.5	50.0	138.5	130.8	73.1	95.5
	Dead "	2	0.0	0.0	0.0	50.0	50.0	150.0	150.0	77.3	116.0
	Live "	37	5.4	2.7	2.7	40.5	48.6	143.2	127.0	77.6	98.5
	All	83	3.6	3.6	1.2	37.3	54.2	148.2	133.7	74.9	100.2
1948	No lambs	18	5.6	5.6	5.6	22.2	61.1	150.0	138.9	73.6	102.2
	Imm. "	22	0.0	0.0	0.0	22.7	77.3	181.8	159.1	70.6	112.3
	Dead "	4	0.0	0.0	0.0	50.0	50.0	150.0	100.0	90.2	90.2
	Live "	43	9.3	0.0	0.0	41.9	48.8	139.5	107.0	76.2	81.5
	All	87	5.7	1.1	1.1	33.3	58.6	152.9	126.4	74.3	94.0
1949	No lambs	6	0.0	0.0	0.0	66.7	33.3	133.3	116.7	75.0	87.5
	Imm. "	31	0.0	3.2	0.0	45.2	51.6	151.6	138.7	75.8	105.2
	Dead "	4	0.0	0.0	0.0	25.0	75.0	175.0	150.0	76.7	115.0
	Live "	42	2.4	0.0	0.0	47.6	50.0	147.6	128.6	74.7	96.1
	All	83	1.2	1.2	0.0	47.0	50.6	149.4	132.5	75.3	99.8
1950	No lambs	42	2.4	0.0	0.0	59.5	38.1	135.7	121.4	71.4	86.7
	Imm. "	43	7.0	0.0	4.7	55.8	32.6	109.3	90.7	75.0	68.0
	Dead "	2	0.0	0.0	0.0	100.0	0.0	100.0	100.0	73.0	73.0
	Live "	72	4.2	0.0	2.8	52.8	40.3	133.3	112.5	76.4	85.9
	All	159	4.4	0.0	2.5	56.0	37.1	130.2	108.8	74.6	81.1

* All percentages are calculated on the basis of ewes present at lambing.

Reproductive Performance of Rambouillet Ewes in 1952 and 1953

			1953 Lamb Production*								
			Percentage of ewes having:								
Ewe's year birth	1952 lambing record	No. ewes	No lambs	Imm. lambs	Dead lambs	One live lamb	Two live lambs	% live lambs born per ewe	% lambs weaned per ewe	Ave. wng. wt.	Pounds lamb weaned per ewe
1945 or before	No lambs	1	0.0	0.0	0.0	100.0	0.0	100.0	100.0	95.0	95.0
	Imm. "	3	0.0	0.0	0.0	66.7	33.3	133.3	133.3	61.2	81.7
	Dead "	1	0.0	0.0	0.0	100.0	0.0	100.0	100.0	85.0	85.0
	Live "	22	4.5	0.0	4.5	54.5	36.4	127.3	95.5	72.4	69.1
	All	27	3.7	0.0	3.7	59.3	33.3	125.9	100.0	72.0	72.0
1946	No lambs	4	0.0	0.0	0.0	100.0	0.0	100.0	100.0	93.0	93.0
	Imm. "	10	0.0	0.0	0.0	70.0	30.0	130.0	70.0	80.1	56.1
	Dead "	0	--	--	--	--	--	--	--	--	--
	Live "	56	8.9	0.0	1.8	35.7	53.6	142.9	112.5	72.0	81.1
	All	70	7.1	0.0	1.4	44.3	47.1	138.6	105.7	73.9	78.2
1947	No lambs	13	7.7	0.0	0.0	30.8	61.5	153.8	107.7	77.6	83.6
	Imm. "	36	2.8	2.8	0.0	44.4	50.0	144.4	111.1	76.1	84.5
	Dead "	1	0.0	0.0	0.0	0.0	100.0	200.0	200.0	68.0	136.0
	Live "	77	11.7	3.9	5.2	37.7	41.6	120.8	102.6	74.8	76.7
	All	127	8.7	3.1	3.1	38.6	46.5	131.5	106.3	75.4	77.7
1948	No lambs	12	16.7	0.0	8.3	41.7	33.3	108.3	83.3	74.8	67.3
	Imm. "	65	3.1	4.6	9.2	35.4	47.7	135.4	106.2	72.7	77.2
	Dead "	3	33.3	0.0	0.0	33.3	33.3	100.0	100.0	70.3	70.3
	Live "	128	10.9	0.0	3.9	42.2	43.0	128.1	109.4	73.1	79.9
	All	208	9.1	1.4	5.8	39.9	43.8	127.4	106.7	73.0	77.9
1949	No lambs	20	15.0	10.0	0.0	40.0	35.0	110.0	100.0	77.0	77.0
	Imm. "	79	5.1	5.1	2.5	45.6	41.8	129.1	94.9	76.5	72.7
	Dead "	8	0.0	0.0	0.0	50.0	50.0	150.0	150.0	77.1	115.6
	Live "	128	2.3	3.9	1.6	55.5	36.7	130.5	107.8	76.4	82.3
	All	235	4.3	4.7	1.7	50.6	38.7	128.9	104.3	76.5	79.8
1950	No lambs	30	13.3	6.6	0.0	73.3	6.6	86.7	70.0	73.4	50.4
	Imm. "	67	6.0	7.5	3.0	70.1	13.4	97.0	70.1	73.6	51.6
	Dead "	11	0.0	9.1	0.0	72.7	18.2	109.1	109.1	74.4	81.2
	Live "	116	4.3	6.9	2.6	67.2	19.0	105.2	87.1	75.9	66.1
	All	224	5.8	7.1	2.2	69.1	15.6	100.4	80.8	74.9	60.5

* All percentages are calculated on the basis of ewes present at lambing.

FLEECE GRADES FOR THE 1953 AND 1954 CLIPS

Fleeces have been graded by spinning counts at shearing time since 1942. Some changes have been made in grade standards and also some changes have been made in assigning spinning counts to blood grades. The spinning count 54's was first used on the 1954 clip and was called 1/4 Blood along with 50's and 48's. Fleeces with a spinning count of 64's or finer and with a staple length of 2 1/2 inches or longer have been classed as Fine Staple; those fleeces with a staple length shorter than 2 1/2 inches have been classed as Fine French. Very few 60/62's fleeces have been classed as 1/2 Blood French and very few 56/58's fleeces have been classed as 3/8 Blood French. The amount of wool grading 50's and coarser has decreased considerably in the last five clips as indicated in the percentage table.

Grades based on mean fiber diameter were obtained from cross sections of blended samples from the shoulder, back and hip. These were obtained from all rams and all yearling ewes.

Rambouillets

The following table shows that average fiber diameter for yearling ewes in 1953 was about 0.5 microns finer than those of the previous three years. The average fiber diameter for mature rams for both 1953 and 1954 were much finer than in any of the previous years. The average fineness of yearling rams was very similar to past years.

Visual grading placed considerably more fleeces in Fine Staple and a lower portion in Fine French. Considerably fewer fleeces were graded as 1/2 Blood which agrees with the cross-section results.

Average Fiber Diameter in Microns for Rambouillets

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Yr. ewes	21.53	21.48	21.01	21.98	21.75	21.46	21.59	21.52	20.99	21.43
Mat. rams	23.91	23.12	23.56	23.24	23.08	22.51	22.77	22.20	21.82	21.95
Yr. rams	21.28	21.06	20.87	21.70	21.21	21.64	21.46	21.08	21.15	21.44

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Grades of Rambouillet Fleeces

	Distribution of Grades Based on Visual Grading									
	Years									
	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Mature ewes										
Fine French	39	19	34	40	43	30	48	37	24	17
Fine Staple	58	75	65	54	50	57	50	62	75	83
1/2 Blood	3	6	1	6	7	13	2	1	1	
Yearling ewes										
Fine French	28	3	9	2	4	12	16	22	12	3
Fine Staple	66	91	88	91	90	76	84	76	87	96
1/2 Blood	6	6	3	7	6	12		2	1	1
Mature rams										
Fine French	2	4	2		10	5	11	7	9	3
Fine Staple	98	96	98	100	37	76	76	92	83	95
1/2 Blood					53	18	13	1	8	2
Yearling rams										
Fine French	2	7	9		6	5	26	13	10	8
Fine Staple	97	93	91	97	85	79	73	87	90	92
1/2 Blood	1			3	9	16	1			
	Distribution of Grades Based on Cross-Section Fiber Diameter									
Yearling ewes										
Fine	78	78	84	62	77	93	91	96	97	98
1/2 Blood	21	20	16	36	22	7	9	4	3	2
3/8 Blood	1	2		2	1					
Mature rams										
Fine	27	36	31	34	44	62	48	80	94	94
1/2 Blood	51	57	60	51	51	37	49	20	6	6
3/8 Blood	20	6	8	14	5	1	3			
1/4 Blood	2	1	1							
Yearling rams										
Fine	83	86	83	71	96	94	98	99	99	98
1/2 Blood	17	14	17	20	4	6	2	1	1	2
3/8 Blood				9						

Targhees

Average fiber diameters for Targhees since 1945, as presented in the following table, show no definite trend in fineness

Average Diameter in Micrcns for Targhees

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Yr. ewes	24.17	24.48	22.34	24.12	23.66	23.56	23.74	23.26	23.60	23.01
Mat. rams	- -	27.21	- -	24.77	25.65	26.45	25.90	25.14	25.48	25.24
Yr. rams	- -	22.48	- -	23.70	22.79	23.05	23.30	23.69	22.81	23.03

Yearling ewes and yearling rams appear slightly finer both in visual grades and cross-section grades. Mature rams show that a higher proportion of 1954 fleeces were placed in Fine Staple and fewer fleeces placed in 3/8 Staple.

Columbias

Mean fiber diameters as shown in the following table showed little change in yearling ewes and yearling rams in 1953 and 1954 over previous years. Mature rams showed considerable finer mean diameters for both 1953 and 1954. Visual grades for all Columbia sheep showed fewer 1/4 Blood fleeces in 1954 and a higher proportion of 3/8 mature and yearling ewe and mature ram fleeces. However, a shift to more 3/8 fleeces was not definite in grades based on cross-section fiber diameter.

Average Diameter in Microns for Columbias

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Yr. ewes	26.61	26.88	- -	27.02	25.67	25.16	26.29	25.93	26.12	25.92
Mat. rams	- -	29.65	- -	30.39	28.92	29.39	28.70	28.89	27.81	27.80
Yr. rams	- -	25.62	- -	26.59	25.81	25.65	25.68	25.76	25.80	25.01

Grades of Targhee Fleeces

	Distribution of Grades Based on Visual Grading									
	Years									
	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Mature ewes										
Fine French	4	4	4	5	2	1			4	1
Fine Staple	11	13	12	21	6	4	12	14	27	28
1/2 Blood	75	70	68	63	54	54	53	52	46	53
3/8 Blood	10	11	15	11	38	39	32	32	22	17
1/4 Blood		2	1		1	2	3	2	1	1
Yearling ewes										
Fine French			2			1				1
Fine Staple	9	8	19	16	12	16	16	17	28	41
1/2 Blood	79	76	64	73	46	61	73	73	58	52
3/8 Blood	11	16	14	9	40	21	10	10	14	6
1/4 Blood	1		1	2	2	1	1			
Mature rams										
Fine French		3					2			
Fine Staple	9	6	9	8		2	4		1	23
1/2 Blood	76	71	73	77	43	44	26	53	49	46
3/8 Blood	15	20	14	15	57	52	66	43	46	31
1/4 Blood			4			2	2	4	4	
Yearling rams										
Fine French				3				2		
Fine Staple	10	8	12	27	13	4	31	15	37	22
1/2 Blood	72	81	64	60	75	51	59	70	54	60
3/8 Blood	18	11	22	10	11	44	10	12	14	18
1/4 Blood			2		1	1		1		

	Distribution of Grades Based on Cross-Section Fiber Diameter									
	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Yearling ewes										
Fine	5	1	61	19	26	15	18	25	18	42
1/2 Blood	81	82	38	59	62	80	77	71	77	54
3/8 Blood	14	17	1	21	12	5	5	4	5	4
1/4 Blood				1						
Mature rams										
Fine		6		18			1	2	2	9
1/2 Blood		26		49	45	32	41	60	48	49
3/8 Blood		40		24	53	61	56	38	50	40
1/4 Blood		28		9	2	7	2			2
Yearling rams										
Fine		56		37	46	40	25	23	44	42
1/2 Blood		36		49	53	59	70	69	52	51
3/8 Blood		8		10	1	1	5	8	4	7
1/4 Blood				4						

Grades of Columbia Fleeces

Distribution of Grades Based on Visual Grading

	Years									
	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Mature Ewes										
1/2 Blood	3	3	3	3	4	3	2	2	5	5
3/8 Blood	48	47	47	45	42	48	50	44	56	70
1/4 Blood	48	48	48	46	50	41	47	53	36	25
L 1/4 Blood	1	2	2	6	4	8	1	1	2	
Yearling Ewes										
Fine Staple							7			
1/2 Blood	4	4	6	7	9	19	26	24	22	20
3/8 Blood	57	42	63	67	70	70	60	62	69	76
1/4 Blood	39	53	30	25	19	11	7	14	9	4
L 1/4 Blood			1	1	2					
Mature Rams										
1/2 Blood	3		3				6		2	6
3/8 Blood	47	26	40	50	61	52	33	68	41	74
1/4 Blood	50	74	55	46	39	33	52	32	57	20
L 1/4 Blood			2	4		14	9			
Com. & Braid						1				
Yearling Rams										
Fine Staple		1						1		
1/2 Blood	8	5	3	5	11	2	11	23	16	11
3/8 Blood	53	57	56	72	77	85	69	58	70	85
1/4 Blood	38	37	40	23	11	13	20	8	14	4
L 1/4 Blood	1		1		1					

Distribution of Grades Based on Cross-Section Fiber Diameter

	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Yearling Ewes										
Fine				3	2		1	1		
1/2 Blood	16	4		26	38	62	29	40	25	32
3/8 Blood	84	93		52	57	38	68	57	74	67
1/4 Blood		3		18	3		2	2	1	1
L 1/4 Blood				1						
Mature Rams										
Fine										
1/2 Blood				4		2	3			
3/8 Blood		40		23	51	35	65	68	85	67
1/4 Blood		55		60	49	63	32	32	15	33
L 1/4 Blood		5		4						
Com. & Braid				9						
Yearling Rams										
Fine		6		2	2	1		1		5
1/2 Blood		40		28	35	43	34	36	30	58
3/8 Blood		51		56	62	54	65	62	67	34
1/4 Blood		3		14	1	2	1	1	3	3
L 1/4 Blood										

Sorting of the 1952 Wool Clip

Some data from sorting of fleeces from the 1952 clip are summarized by breed, sex and age groups in the accompanying tables. This work was done in cooperation with the Wool Division, Livestock Branch, Production and Marketing Administration and involved approximately 33,000 pounds of grease wool. Individual fleeces from 1952 Rambouillet, 1130 Targhee and 862 Columbia sheep were sorted by one commercial wool sorter from the Wool Division. The matchings and off sorts from each fleece were individually weighed, recorded and binned according to grade and staple length.

Fleeces of yearling ewes and rams had an average growth period of about 410 days. Fleeces of mature ewes and rams represent one year's growth. All mature ewes were crutched in March prior to shearing in May and approximately 1/2 pound of wool was clipped from each ewe. The crutchings are not included in the fleece weights or processing.

Grade, Staple Length and Standards Used in Grading the 1952, 1953 and 1954 Clips

Grade	Staple Length (in.)	Standard Spinning Count
F. S.	2 1/2 and longer	64's and Finer
F. Fr.	Under 2 1/2	64's and Finer
1/2 St.	2 1/2 and longer	60's and 62's
1/2 Fr.	Under 2 1/2	60's and 62's
3/8 St.	3 and longer	56's and 58's
3/8 Fr.	Under 3	56's and 58's
1/4	3 1/2	50's and 48's
1/4 (1954 clip)	3 1/2	54's/50's and 48's
L 1/4	4	46's and Coarser

Cooperative Studies with 1952 Clip

Carding of Individual Targhee Fleeces:

Main sorts of 243 yearling ewes, 117 yearling rams, and 45 mature ram fleeces were scoured and carded individually by the Animal Husbandry Division, Beltsville, Maryland.

Top Making Under Contract with Forstmann Woolen Company:

Wool made available for top making through contract with the Forstmann Woolen Company, Passaic, New Jersey, consisted of 1,506 pounds Fine Staple, unscoured matchings from mature Rambouillet ewes; 1,505 pounds 60/62's Staple unscoured matchings from mature Targhee ewes; and 1,514 pounds 56/58's Staple, unscoured matchings from mature Columbia ewes.

Processing of 1952 Wool:

Approximately 33,000 pounds of grease wool were used in cooperation with the Wool Division, Livestock Branch, Production and Marketing Administration for studies of the commercial values of sorted wools. These wool sorts were processed into top by a commercial scouring and combing company. The accompanying tables on pages 82-83 are wool sorting summaries and the table on page 84 is a summary of the processing of these wools into top, noil, and waste.

Considerable more off sorts (stained, tags, and seedy) were removed from the Rambouillet and Columbia yearling ewes than from the mature ewes of the same breed. Targhee yearling ewes fleeces produced less off-sort wools than Targhee mature ewe fleeces. Rambouillet yearling and mature ewe fleeces sorted into 87 and 95 percent, respectively, 64's and finer quality wool with 23 and 39 percent, respectively, of the fine wools being sorted as French lengths of less than two and one-half inches. The major portion of the Targhee yearling ewe wool (56 percent) was sorted as 60/62's quality with the remaining wools nearly equally divided into 64/70's and 56/58's quality wools. Over 80 percent of the Targhee mature ewe wool was equally divided between 60/62 and 56/58's quality wools with the remaining portion being 64/70's quality. Columbia yearling ewe fleeces are the most variable as to wool quality with 15 percent sorted as 60/62's, 48 percent 56/58's, 18 percent 50's, and 15 percent as off-sort wools. Approximately 75 percent of the Columbia mature ewe was sorted as 50/58's quality with 14 percent coarser wools and nearly 9 percent off-sort wool.

There was very little difference in the sort distribution percentages between the Rambouillet yearling and mature ram fleeces; however, approximately 5 percent more of the yearling 64/70's quality wool was classed as French length. Targhee yearling ram wool was sorted into 12 percent 64/70's, 44 percent 60/62's and 20 percent 56/58's quality wools with 13 percent off-sort wools. Targhee mature ram wool was sorted equally into 60/62's and 56/58's quality grades with only 6 percent coarser wools and 8 percent off-sort wools. Columbia yearling ram wool contained 21 percent 60/62's, 46 percent 56/58's, 17 percent coarser wools, and 13 percent off-sort wools. Columbia mature ram wool was very uniform with 47 percent 56/58's, 41 percent 50/48's, and 12 percent off-sort wools.

1952 Wool Sorting Summary - Ewes

Description	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted
	Rambouillet Yearling Ewes				Rambouillet Mature Ewes			
Fine Staple	322	2302.3	7.15	63.52	890	6994.3	7.86	55.60
Fine French	316	851.0	2.69	23.48	1026	4937.4	4.81	39.25
1/2 Staple	95	143.1	1.51	3.95	74	180.2	2.43	1.43
1/2 French	1	0.4	0.40	0.01	24	21.3	0.89	0.17
3/8 Staple	7	4.3	0.61	0.12	5	2.6	0.52	0.02
3/8 French	--	--	--	--	2	0.4	--	--
Off Sorts	379	323.4	0.85	8.92	790	443.7	0.56	3.53
Total	401	3624.5	9.04	100.00	1211	12579.9	10.39	100.00
	Targhee Yearling Ewes				Targhee Mature Ewes			
Fine Staple	41	243.7	5.94	10.21	104	850.8	8.18	11.17
Fine French	35	33.7	0.96	1.41	29	106.0	3.65	1.39
1/2 Staple	224	1350.1	6.03	56.56	384	2904.7	7.56	38.12
1/2 French	175	143.9	0.82	6.03	42	70.5	1.68	0.93
3/8 Staple	193	422.7	2.19	17.71	458	2452.9	5.35	32.19
3/8 French	40	26.3	0.66	1.10	80	119.4	1.49	1.57
50's	33	17.9	0.54	0.75	210	355.2	1.69	4.66
48's					16	56.4	3.53	0.74
46's					6	21.4	3.57	0.28
Off Sorts	258	148.6	0.57	6.23	654	682.8	1.04	8.96
Total	260	2386.9	9.18	100.00	659	7620.1	11.56	100.01
	Columbia Yearling Ewes				Columbia Mature Ewes			
Fine Staple	1	6.7	6.70	0.41	1	9.1	9.10	0.14
1/2 Staple	43	253.1	5.89	15.67	18	139.4	7.74	2.20
1/2 French	3	2.1	0.70	0.13	5	13.7	2.74	0.22
3/8 Staple	147	780.0	5.31	48.29	305	2290.6	7.51	36.13
3/8 French	14	4.6	0.33	0.28	15	41.7	2.78	0.66
50's	135	304.6	2.26	18.86	439	2388.8	5.44	37.68
48's	22	19.3	0.88	1.19	197	787.2	3.99	12.41
46's	1	1.3	1.30	0.08	48	111.9	2.33	1.76
Off Sorts	165	243.6	1.48	15.08	523	557.9	1.07	8.80
Total	165	1615.3	9.79	99.99	526	6340.3	12.05	99.99

1952 Wool Sorting Summary - Rams

Description	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted
	Rambouillet Yearling Rams				Rambouillet Mature Rams			
Fine Staple	216	1811.1	8.38	73.65	101	1308.2	12.95	80.48
Fine French	188	414.4	2.35	17.95	87	206.9	2.38	12.73
1/2 Staple	64	53.6	0.84	2.18	9	36.9	4.10	2.27
1/2 French	21	10.9	0.52	0.44	2	1.4	0.70	0.09
3/8 Staple	2	1.4	0.70	0.06	1	0.2	0.20	0.01
3/8 French					1	0.3	0.30	0.01
Off Sorts	189	140.7	0.74	5.72	90	71.5	0.79	4.40
Total	233	2459.1	10.55	100.00	107	1625.4	15.19	99.99
	Targhee Yearling Rams				Targhee Mature Rams			
Fine Staple	28	206.9	7.39	12.07				
Fine French	7	27.2	3.89	1.59				
1/2 Staple	131	848.0	6.47	44.45	32	318.2	9.94	41.30
1/2 French	18	16.7	0.93	0.97	10	10.3	1.03	1.34
3/8 Staple	136	341.8	2.51	19.93	48	327.0	6.81	42.45
3/8 French	3	4.0	1.33	0.23	4	3.3	0.83	0.43
50's	34	47.5	1.40	2.77	19	46.3	2.44	6.01
48's	1	0.4	0.40	0.02				
Off Sorts	158	222.2	1.41	12.96	50	65.3	1.31	8.48
Total	161	1714.7	10.65	99.99	50	770.4	15.41	100.01
	Columbia Yearling Rams				Columbia Mature Rams			
Fine Staple	2	14.3	7.15	0.93				
Fine French	1	2.5	2.50	0.16				
1/2 Staple	49	322.5	6.58	20.92				
1/2 French	6	17.5	2.92	1.13				
3/8 Staple	127	721.0	5.68	46.77	19	213.7	11.25	47.19
3/8 French	2	1.9	0.95	0.12				
50's	96	238.7	2.49	15.49	27	167.3	6.20	36.95
48's	12	22.2	1.86	1.44	5	17.9	3.58	3.95
46's					1	0.7	0.70	0.15
Off Sorts	145	200.8	1.38	13.03	28	53.2	1.90	11.75
Total	145	1541.4	10.63	99.99	28	452.8	16.17	99.99

Summary from Processing Each Lot from 1952 Clip

Description	Grease weight	Scoured weight	Clean yield	Top weight	Noil weight	Waste weight	Top %	Noil %	Noil % of top and noil
Fine Staple	11,745	5,819	49.54	4,777	797	304	40.7	6.8	14.3
Fine French	6,597	3,104	47.05	2,553	441	188	39.5	6.7	14.7
60/62 Staple	2,957	1,497	50.63	1,260	146	73	42.6	4.9	10.4
56/58 Staple	4,992	2,762	55.32	2,428	226	140	48.6	4.5	8.5
50's	3,306	1,905	57.62	1,724	149	74	52.1	4.5	7.9
46/48's	1,084	648	59.76	589	41	30	54.3	3.8	6.5
Seedy 60's & Finer	977	421	43.08	327	67	29	35.0	7.2	17.0
Seedy 58's & Coarser	1,045	506	48.42	376	65	48	35.9	6.2	14.7
Crutching Fine	557	222	39.94	139	63	17	24.9	11.3	31.1
Crutching Medium	513	227	44.30	166	44	28	32.4	8.6	20.9

The distribution of clean yields among grades of wool were very much as expected with approximately 2 percent spread between blood grade groups with the exception of a 5 percent difference between the 60/62's and 56/58's quality wools. The top percentage on grease weights and noil percent of top and noil were good with normal differences between grades.

Sorting of the 1953 Wool Clip

The objectives of this work are to determine the minimum amount and kind of sorting required for satisfactory processing results and the relationships between sorted, partially sorted and unsorted or graded lots of grease wool and the resultant top. Some data from sorting of fleeces and processing lots of grease wool into top are summarized in the accompanying tables:

Percentage of Sorted, Partially Sorted and Non-Sorted Wools in Each Lot of the 1953 Clip

	Fine Staple lot			Fine French lot		
Description	Completely sorted	Partially sorted	Non-sorted	Completely sorted	Partially sorted	Non-sorted
Fine Staple main sort	100.00	71.95	89.01			
Fine Staple pieces						0.08
Fine Franch main sort		19.29		66.30		99.38
Fine French pieces		8.16	9.98	33.70		
60/62's Staple pieces			0.17			0.04
60/62's French pieces			0.03			
Seedy		0.60	0.76			0.50
Total	100.00	100.00	99.95	100.00		100.00

	60/62's Staple lot			56/58's Staple lot		
60/62's Staple main sort	99.51	84.98	87.01			
60/62's Staple pieces	0.49	0.36				
60/62's French main sort		8.60	6.19			
60/62's French pieces		2.19	2.30			
56/58's Staple main sort				99.62	90.98	88.30
56/58's Staple pieces			0.45	0.38	0.39	
56/58's French main sort					2.09	3.91
56/58's French pieces			0.05		2.61	2.72
50's Pieces						1.45
48's Pieces						0.06
Seedy		3.86	3.99		3.93	3.56
Total	100.00	99.99	99.99	100.00	100.00	100.00

	50/58's Staple lot		
50's Main sort	77.46	79.23	81.26
50's Pieces	4.33	3.01	.17
48's Main sort	16.46	12.39	13.65
48's Pieces	1.75	2.05	1.38
56/58's Pieces			0.34
Seedy		3.31	3.21
Total	100.00	99.99	100.01

1953 Wool Sorting Summary - Ewes

Description	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted
	Rambouillet Yearling Ewes				Rambouillet Mature Ewes			
Fine Staple	259	2009.9	7.76	74.72	871	7425.9	8.53	64.88
Fine French	278	389.0	1.40	14.46	1123	3533.9	3.15	30.87
1/2 Staple	17	35.4	2.08	1.32	29	163.9	5.65	1.43
1/2 French	3	0.9	0.30	0.03	20	34.4	1.72	0.30
3/8 Staple								
3/8 French	2	1.4	0.70	0.05	2	0.6	0.30	0.01
Off Sorts	295	253.3	0.86	9.42	818	287.2	0.35	2.51
Total	295	2689.9	9.12	100.00	1163	11445.9	9.84	100.00
	Targhee Yearling Ewes				Targhee Mature Ewes			
Fine Staple	52	418.0	8.04	24.42	209	1935.2	9.26	22.87
Fine French	38	29.1	0.77	1.70	150	363.8	2.43	4.30
1/2 Staple	98	862.1	8.80	50.36	345	3247.9	9.41	38.39
1/2 French	57	41.7	0.73	2.43	137	345.0	2.52	4.08
3/8 Staple	23	207.6	9.03	12.13	186	1724.0	9.27	20.38
3/8 French	14	8.1	0.58	0.47	70	149.1	2.13	1.76
50's	1	0.3	0.30	0.02	21	85.5	4.07	1.01
48's	3	2.0	0.67	0.12	3	10.7	3.57	0.13
46's					5	28.0	5.60	0.33
Off Sorts	166	143.0	0.86	8.35	766	571.2	0.75	6.75
Total	172	1711.9	9.95	100.00	810	8460.4	10.44	100.00
	Columbia Yearling Ewes				Columbia Mature Ewes			
Fine Staple					1	8.9	8.90	0.14
Fine French					2	10.1	5.05	0.16
1/2 Staple	22	169.9	7.72	16.06	27	249.8	9.25	4.02
1/2 French	18	10.0	0.55	0.95	6	12.9	2.15	0.21
3/8 Staple	77	595.9	7.74	56.32	319	3035.7	9.52	48.90
3/8 French	56	35.9	0.64	3.39	200	230.7	1.15	3.72
50's	38	119.1	3.13	11.26	221	1772.0	8.02	28.54
48's	1	1.5	1.50	0.14	83	393.5	4.74	6.34
46's	3	2.9	0.97	0.27	42	175.5	4.18	2.83
Off sorts	104	122.9	1.18	11.61	505	318.7	.63	5.13
Total	104	1058.1	10.17	100.00	566	6207.8	10.97	99.99

1953 Wool Sorting Summary - Rams

Description	No. of fleeces contri- buting	Weight of wool sorted	Ave. wt. per fl. contri- buting	Percent of wool sorted	No. of fleeces contri- buting	Weight of wool sorted	Ave.wt. per fl. contri- buting	Percent of wool sorted
	Rambouillet Yearling Rams				Rambouillet Mature Rams			
Fine Staple	146	1281.4	8.78	74.16	91	1059.4	11.64	68.93
Fine French	151	355.8	2.36	20.59	102	249.0	2.44	16.20
1/2 Staple					10	111.5	11.15	7.25
1/2 French					9	6.6	0.73	0.43
3/8 Staple					3	0.9	0.30	0.07
Off Sorts	143	90.6	0.63	5.24	103	109.6	1.06	7.13
Total	164	1727.8	10.53	99.99	109	1537.0	14.10	100.01
	Targhee Yearling Rams				Targhee Mature Rams			
Fine Staple	36	298.9	8.30	26.94	1	12.1	12.10	1.09
Fine French	33	30.8	0.93	2.77	1	0.8	0.80	0.07
1/2 Staple	56	531.2	9.49	47.87	36	446.5	12.40	40.04
1/2 French	42	36.8	0.88	3.32	22	14.9	0.68	1.34
3/8 Staple	16	145.0	9.06	13.07	39	454.5	11.65	40.75
3/8 French	7	4.8	0.69	0.43	15	10.1	0.67	0.91
50's					12	44.2	3.68	3.96
48's					1	14.1	14.10	1.26
Off Sorts	89	62.1	0.70	5.60	74	118.0	1.59	10.58
Total	106	1109.6	10.47	100.00	75	1115.2	14.87	100.00
	Columbia Yearling Rams				Columbia Mature Rams			
1/2 Staple	14	121.4	8.67	12.07	1	11.7	11.70	1.79
1/2 French	5	2.7	0.54	0.27	1	1.3	1.30	0.20
3/8 Staple	63	565.4	8.97	56.21	18	208.2	11.57	31.88
3/8 French	11	4.0	0.36	0.40	2	1.3	0.65	0.20
50's	27	158.3	5.86	15.74	21	276.3	13.16	42.30
48's					6	74.7	12.45	11.44
46's	3	5.1	1.70	0.51	4	5.2	1.30	0.80
Off Sorts	88	149.0	1.69	14.81	42	74.4	1.77	11.39
Total	88	1005.9	11.43	100.01	44	653.1	14.89	100.00

There was no definite trend in the amount of sorting grades of the sex and age groups of Rambouillet wool between the 1952 and 1953 clips. Considerably more Targhee wool from both age and sex groups was sorted into the 64/70's quality grades from the 1953 clip than from the 1952 clip. Considerably more Columbia wool from yearling and mature ewes was sorted into the 56/58's quality grades and less sorted into the 50/48's quality grades from the 1953 clip than from the 1952 clip. Perhaps this change to finer wools is due to sorter differences rather than to actual fineness of the fibers.

Summary from Processing Each Lot from the 1953 Clip

Grade	Comb-ing	Grease weight	Scoured weight (12%MC)	Clean yield (%)	Top weight (15% regain)	Noil weight (15% regain)	Waste weight	Top % on grease	Top % on scoured	Noil % on grease	Noil % on scoured	Noil % on top and noil
64's St.[1]	Noble	3590	1815	50.57	1491	242	51	41.5	82.1	6.7	13.3	13.9
64's St.[2]	Noble	5047	2483	49.20	2043	390	77	40.5	82.3	7.7	15.7	16.0
64's St.[3]	Noble	4100	2037	49.68	1655	312	60	40.4	81.3	7.6	15.4	15.8
64's St.[1]	French	980	569	58.06	402	36*	36	41.0	70.7	3.7	6.3	8.2
64's St.[2]	French	1098	636	57.94	459	35*	37	41.8	72.1	3.2	5.5	7.1
64's St.[3]	French	1045	629	60.21	424	36*	52	40.6	67.4	3.4	5.7	7.8
64's Fr.[1]	Noble	1503	705	46.91	560	117	31	37.3	79.4	7.8	16.6	17.3
64's Fr.[3]	Noble	1101	504	45.76	430	80	17	39.1	85.4	7.3	15.9	15.7
1/2 St.[1]	Noble	675	353	52.22	301	42	11	44.6	85.4	6.3	12.0	12.3
1/2 St.[2]	Noble	869	449	51.62	383	43	22	44.1	85.4	5.0	9.6	10.1
1/2 St.[3]	Noble	868	435	50.06	378	50	20	43.5	87.0	5.7	11.5	11.6
1/2 St.[1]	French	726	426	58.65	321	21*	32	44.2	75.4	2.9	4.9	6.1
1/2 St.[2]	French	777	460	59.23	334	23*	33	43.0	72.6	3.0	5.0	6.4
1/2 St.[3]	French	726	440	60.65	321	22*	29	44.2	72.9	3.0	5.0	6.4
3/8 St.[1]	Noble	2187	1203	54.99	1040	122	45	47.6	86.5	5.6	10.2	10.5
3/8 St.[2]	Noble	2136	1150	53.85	973	123	39	45.6	84.6	5.7	10.7	11.2
3/8 St.[3]	Noble	2281	1249	54.73	1086	116	53	47.6	87.0	5.1	9.3	9.6
1/4 St.[1]	Noble	843	497	58.90	441	40	13	52.3	88.8	4.7	8.0	8.2
1/4 St.[2]	Noble	991	639	64.48	580	67	19	58.5	90.8	6.8	10.5	10.4
1/4 St.[3]	Noble	881	469	53.21	373	39	17	42.3	79.6	4.5	8.4	9.6

[1] Completely sorted wool [2] Partially sorted wool [3] Unsorted wool

* Moisture content unknown

Clean yields from the 64/70's, 60/62's, and 56/58's quality wool lots were from 0.25 to 2.16 percent higher from the completely sorted lots than from the unsorted lots. There was also a slightly higher percentage of top on grease weight basis from completely sorted lots than from unsorted lots. Percentage of noil on top and noil was not consistent among the types of sorting of the three finer grade quality groups. Reasons for the extreme variation in order among the types of sorting of clean yields, top yields, and percentage of noil on top and noil of the 50/48's (one-quarter blood) quality wool are not clear.

Fleece Weight at Shearing - 1952 and 1953

	MATURE		YEARLING		ALL	
	1952 Average Fl. Wt.	1953 Average Fl. Wt.	1952 Average Fl. Wt.	1953 Average Fl. Wt.	1952 Average Fl. Wt.	1953 Average Fl. Wt.
EWES						
K	12.42	11.29	10.42	10.59	11.92	11.17
K_2	12.22	11.03	9.86	12.06	11.76	11.12
K_1B	12.47	11.45	--	--	12.47	11.45
K_1L	--	9.20	9.10	13.10	9.10	11.15
Columbia	12.40	11.26	10.36	10.69	10.40	11.17
T	11.63	10.66	9.57	10.35	10.89	10.60
T_1	12.18	11.26	10.31	9.57	12.09	11.05
Targhee	11.81	10.79	9.60	10.24	11.19	10.70
RW	10.88	10.35	9.27	9.25	10.47	10.17
XW, W	10.46	10.04	9.10	9.39	10.13	9.90
S	10.85	10.45	9.73	9.90	10.55	10.33
Rambouillet	10.63	10.22	9.29	9.50	10.30	10.07
Total Ewes	11.34	10.63	9.60	9.94	10.90	10.51
RAMS						
K	16.54	16.75	10.70	11.96	11.64	13.62
K_2	--	--	--	13.63	--	13.63
Columbia	16.54	16.75	10.70	12.08	11.64	13.62
T	15.99	16.10	10.62	11.17	11.90	13.18
T_1	14.90	16.00	11.95	10.83	12.54	13.79
Targhee	15.97	16.10	10.66	11.16	11.92	13.21
RW	15.84	15.64	10.90	10.88	12.65	12.95
XW, W	15.32	14.26	10.46	10.40	12.20	12.19
S	15.97	15.90	11.24	11.84	12.03	12.81
Rambouillet	15.53	14.85	10.77	10.96	12.27	12.53
Total Rams	15.80	15.62	10.72	11.29	12.02	12.98
Grand Total	11.66	11.04	10.04	10.46	11.10	10.90

1954 Wool Sorting Summary - Ewes

Description	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted
	Rambouillet Yearling Ewes				Rambouillet Mature Ewes			
Fine Staple	412	3071.2	7.45	81.41	925	8692.6	9.40	77.01
Fine French	399	359.2	0.90	9.52	1065	2501.3	2.35	22.16
1/2 Staple	268	155.7	0.58	4.13	115	71.6	0.62	0.63
1/2 French	8	4.1	0.51	0.11	2	0.7	0.35	0.01
3/8 Staple	9	2.3	0.25	0.06	6	1.7	0.28	0.02
3/8 French	1	.3	0.30	--	1	0.3	0.30	--
Off Sorts	374	179.5	0.48	4.76	62	18.6	0.30	0.16
Total	427	3772.3	8.83	99.99	1114	11286.8	10.13	99.99
	Targhee Yearling Ewes				Targhee Mature Ewes			
Fine Staple	121	804.2	6.65	31.22	239	2231.7	9.34	24.91
Fine French	182	105.2	0.58	4.08	227	197.3	0.87	2.20
1/2 Staple	227	1183.3	5.21	45.94	505	4122.5	8.16	46.02
1/2 French	37	20.7	0.56	0.80	352	182.5	0.52	2.04
3/8 Staple	149	225.9	1.52	8.77	324	1928.3	5.95	21.52
3/8 French	8	4.6	0.57	0.18	153	71.3	0.47	0.79
54's	--	--	--	--	6	48.7	8.10	0.54
50's	6	4.3	0.72	0.17	49	34.2	0.70	0.38
Off Sorts	279	227.7	0.82	8.84	291	142.3	0.49	1.59
Total	287	2575.9	8.97	100.00	841	8958.8	10.65	99.99
	Columbia Yearling Ewes				Columbia Mature Ewes			
Fine Staple					3	28.1	9.37	0.47
Fine French	34	21.9	0.64	1.31	6	3.8	0.63	0.06
1/2 Staple	35	226.7	6.48	13.58	23	207.3	9.01	3.49
1/2 French	2	6.5	3.25	0.39	17	7.4	0.43	0.12
3/8 Staple	170	1047.4	6.16	62.76	379	3816.6	10.07	64.24
3/8 French	143	105.2	0.73	6.30	405	188.4	0.47	3.17
54's	6	51.9	8.65	3.11	102	1164.0	11.39	19.59
50's	128	94.7	0.74	5.67	182	447.5	2.46	7.53
Off Sorts	175	114.6	0.65	6.87	170	78.3	0.46	1.32
Total	182	1668.9	9.17	99.99	534	5941.4	11.13	99.99

Considerably less wool was sorted as off sorts from the mature animals than from the yearling animals in all three breeds. Approximately 13 percent more wool of French length was removed from mature Rambouillet ewe fleeces than from yearling Rambouillet ewe fleeces. Considerably more 56/58's wool was sorted from Targhee mature ewe fleeces than from Targhee yearling ewe fleeces, and considerably more 54/50's wool was sorted from the Columbia mature ewe fleeces than from the Columbia yearling ewe fleeces.

1954 Wool Sorting Summary - Rams

Description	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted	No. of fleeces contributing	Weight of wool sorted	Ave. wt. per fl. contributing	Percent of wool sorted
	Rambouillet Yearling Rams				Rambouillet Mature Rams			
Fine Staple	197	2160.3	10.97	83.15	121	1819.0	15.03	86.54
Fine French	212	360.9	1.70	13.89	122	202.8	1.66	9.65
1/2 Staple	60	31.3	0.52	1.20	5	31.1	6.22	1.48
1/2 French	3	0.7	0.23	0.03	1	0.1	0.10	--
Off Sorts	54	44.9	0.83	1.73	45	48.8	1.08	2.32
Total	214	2598.1	12.14	100.00	127	2101.8	16.55	99.99
	Targhee Yearling Rams				Targhee Mature Rams			
Fine Staple	42	427.8	10.19	18.74	15	216.5	14.43	19.28
Fine French	146	104.4	0.71	4.57	15	10.7	0.71	0.95
1/2 Staple	145	1257.6	8.67	55.08	43	483.7	11.25	43.06
1/2 French	1	12.6	12.60	0.55	26	15.7	0.60	1.40
3/8 Staple	81	418.7	5.17	18.34	40	358.9	8.97	31.95
3/8 French	33	19.9	0.60	0.87	11	7.2	0.65	0.64
50's	19	9.3	0.49	0.41	13	9.0	0.69	0.80
Off Sorts	66	32.8	0.50	1.44	27	21.5	0.80	1.91
Total	190	2283.1	12.02	100.00	69	1123.2	16.28	99.99
	Columbia Yearling Rams				Columbia Mature Rams			
Fine French					1	1.1	1.10	0.19
1/2 Staple	14	126.3	9.02	8.35	2	27.6	13.80	4.74
1/2 French	13	9.6	0.74	0.63	2	0.9	0.45	0.15
3/8 Staple	116	1173.5	10.12	77.59	27	398.3	14.75	68.44
3/8 French	103	71.2	0.69	4.71	23	14.9	0.65	2.56
54's	2	28.4	14.20	1.88	3	50.3	16.77	8.64
50's	65	56.8	0.87	3.75	18	54.6	3.03	9.38
48's	--	--	--	--	1	18.6	18.60	3.19
Off Sorts	58	46.7	0.81	3.09	21	15.7	0.75	2.70
Total	122	1512.5	12.40	100.00	35	582.0	16.63	99.99

Fleeces from Rambouillet yearling and mature rams are very uniform with 97 percent of the wool sorted as 64/70's quality. Approximately 23 percent more wool from Targhee mature ram fleeces was sorted as 56/58's quality than from Targhee yearling ram fleeces. Fleeces from Columbia rams were very uniform with 77 and 68 percent, respectively, from yearling and mature rams sorted as 56/58's quality.

Summary From Processing Each Lot From the 1954 Clip
All Lots Noble Combed

Grade	Grease weight	Scoured weight (12%MC)	Clean Yield (%)	Top weight (15% regain)	Noil weight (15% regain)	Waste weight	Top % on grease	Top % on scoured	Noil % on grease	Noil % on scoured	Noil % on Top & Noil
64's St.[1]	6288	2661.2	42.32	2094.0	427.0	251.0	33.3	78.7	6.8	16.0	16.9
64's St.[2]	7228	3036.1	42.00	2305.5	519.5	328.0	31.9	75.9	7.2	17.1	18.4
64's St.[3]	7314	3196.8	43.71	2486.0	551.0	295.0	34.0	77.8	7.5	17.2	18.1
64's Fr.[1]	1197	497.0	41.52	360.0	95.0	52.8	30.1	72.4	7.9	19.1	20.9
64's Fr.[3]	727	299.5	41.20	185.0	59.0	33.5	25.4	61.8	8.1	19.7	24.2
60/62's [1]	2333	1144.6	49.06	837.0	135.0	85.0	35.9	73.1	5.8	11.8	13.9
60/62's [2]	2474	1130.5	45.70	881.0	149.0	129.0	35.6	77.9	6.0	13.2	14.5
60/62's [3]	2495	1189.4	47.67	927.0	154.0	113.5	37.2	77.9	6.2	12.9	14.3
56/58's [1]	2999	1523.4	50.80	1147.5	122.0	136.0	38.3	75.3	4.1	8.0	9.6
56/58's [2]	3199	1555.0	48.61	1277.5	210.0	174.0	39.9	82.2	6.6	13.5	14.1
56/58's [3]	3339	1806.0	54.07	1345.5	224.0	152.5	40.3	74.5	6.7	12.4	14.3
48/50/54's[1]	665	366.9	55.17	271.0	31.0	55.0	40.8	73.9	4.7	8.4	10.3
48/50/54's[2]	635	337.0	53.07	278.5	28.0	42.5	43.9	82.6	4.4	8.3	9.1
48/50/54's[3]	632	346.0	54.75	243.0	24.0	46.0	38.4	70.2	3.8	6.9	9.0

[1] Completely sorted wool
[2] Partially sorted wool
[3] Unsorted wool

Clean yields, top yields, and noil yields are not consistent between types of sorting and grade quality wool lots indicating very little quality differences among the three types of sorting.

Summary of Micronaire Fineness

	1954 Mill Lots					
	Processed at Commercial Mill			Processed at ARS Wool Laboratory, Beltsville, Md.		
Type Sorted	Clean scoured	Top	Noils	Clean scoured	Top	Noils
	(Microns)			(Microns)		
Fine Staple1/	20.70	21.58	20.23	20.58	21.07	20.45
Fine Staple2/	19.90	21.25	19.90	20.97	21.13	20.66
Fine Staple3/	20.23	21.38	20.17	21.64	21.26	20.51
Fine French1/	20.96	22.27	20.57	21.02	21.09	21.06
Fine French3/	20.06	22.23	20.35	21.03	21.53	20.48
60/62's Staple1/	22.07	23.68	21.59	23.79	23.59	22.43
60/62's Staple2/	22.39	24.20	21.19	22.25	24.17	22.72
60/62's Staple3/	21.05	24.03	22.18	21.94	23.65	23.09
56/58's Staple1/	25.38	26.87	23.50	26.10	26.15	24.20
56/58's Staple2/	25.56	26.87	23.46	25.34	26.15	24.44
56/58's Staple3/	24.64	27.27	23.65	27.34	26.82	25.05
48/50/54's1/	26.24	29.93	25.21	30.03	29.01	25.81
48/50/54's2/	27.86	29.78	24.80	28.16	29.98	25.55
48/50/54's3/	26.28	30.23	25.50	28.42	30.22	26.77

1/ Completely sorted

2/ Partially sorted

3/ Non-sorted or graded wool

Discrepancies between mill lots and the Beltsville samples are probably due to sampling differences.

Summary of Grease Staple Length

	1954 Mill Lots								
	Completely Sorted			Partially Sorted			Non-sorted or Graded Wool		
	Average length	Standard deviation	Coeff. of variation	Average length	Standard deviation	Coeff. of variation	Average length	Standard deviation	Coeff. of variation
	(inches)	(inches)	(percent)	(inches)	(inches)	(percent)	(inches)	(inches)	(percent)
Fine Staple	2.78	.468	16.83	2.75	.483	17.56	3.04	.433	14.24
Fine French	2.28	.423	18.55	--	--	--	2.21	.385	17.42
60/62's Staple	3.01	.490	16.28	3.18	.440	13.84	3.17	.468	14.76
56/58's Staple	3.45	.603	17.48	3.48	.555	15.95	3.55	.565	15.92
48/50/54's Staple	3.68	.565	15.43	3.56	.548	15.39	3.82	.628	16.44

The average staple length of the non-sorted wools in each grade quality group (except Fine French) was longer than the average staple length of similar quality completely sorted wools. The cause of this difference between the sorted and unsorted wools is not clear.

Percentage of Various Sorts of Wool From Each Clip

	1950	1951	1952	1953	1954
	Percent of Clip	Percent of Clip	Percent of Clip	Percent of Clip	Percent of Clip
MATCHINGS					
Fine Staple	30.72	28.06	31.11	42.11	46.35
Fine French	9.52	18.53	15.36	6.74	4.35
60/62's Staple	12.09	14.36	14.86	16.01	17.48
60/62's French	2.75	1.27	.69	.41	.37
56/58's Staple	11.63	16.72	16.81	18.77	20.99
56/58's French	2.07	1.20	.54	.40	.42
50/48's	14.35	10.02	10.07	7.15	4.26*
46's	2.21	.24	.48	.55	--
Total Matchings	85.35	90.40	89.92	92.14	94.22
OFF SORTS					
Crutchings - Fine	1.76	1.46	1.26	1.39	1.33
Crutchings - Medium	1.60	1.46	1.16	1.39	1.23
Seedy-Stain-Tags	11.28	6.68	7.66	5.08	3.22
Total Off Sorts	14.64	9.60	10.08	7.86	5.78
Percentage of Fleeces by Breed in Each Clip					
Columbia	23.25	22.23	21.81	21.68	21.10
Targhee	25.74	28.20	28.80	31.30	33.42
Rambouillet	51.01	49.57	49.39	47.02	45.98

* Matching was made of 54/50/48's.

The year to year discrepancies in the percentages of the various grades of wool may be explained in part by the use of three different sorters in four years or perhaps actual differences in the wool produced.

Fineness and Variability of Tops Noble Combed from Grease Wool Lots
During the Years 1949-1950-1951-1952
Wool Standards Laboratory

Year	Description	Average diameter (Microns)	Standard deviation (Microns)	Coeff. of variation (Percent)	Fiber distribution in percent				
					10.0-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0
1949	64's Staple	22.2	4.7	21.1	33.3	61.2	5.2	0.3	
1950	64's Staple	21.8	4.7	21.6	34.5	61.3	3.8	0.5	
1951	64's Staple	22.6	4.9	21.7	34.0	60.0	5.3	0.7	
1952	64's Staple	22.3	4.6	20.5	34.9	58.6	6.4	0.1	
1949	60/62's St.	24.3	5.4	22.1	21.2	65.6	12.4	0.9	
1950	60/62's St.	24.0	5.3	21.9	22.3	65.3	11.8	0.5	
1951	60/62's St.	25.0	5.6	22.4	18.4	64.3	16.3	1.1	
1952	60/62's St.	24.7	5.2	21.2	18.8	66.5	13.2	1.5	
1949	56/58's St.	24.1	6.2	25.7	25.4	59.9	12.5	2.2	
1950	56/58's St.	24.5	5.5	22.5	20.6	64.5	13.8	0.0	1.1
1951	56/58's St.	27.3	6.7	24.4	13.8	54.3	27.5	4.2	0.2
1952	56/58's St.	26.9	6.2	22.8	11.1	62.3	23.8	2.7	0.1
1950	50's	27.8	6.3	22.7	9.8	57.2	29.0	3.8	0.2
1951	50's	30.1	7.3	24.3	7.9	45.2	37.7	8.6	0.6
1952	50's	29.4	7.3	24.9	9.3	45.3	37.5	7.3	0.6
1951	48/46's	33.2	7.7	23.1	2.9	32.8	47.5	14.5	2.3
1952	48/46's	32.0	7.7	24.0	4.3	36.7	44.8	13.0	1.2

Fiber Length from Grease Wool Lots During the Years 1949-1950-1951-1952
Wool Standards Laboratory

		Top			Grease wool		
Year	Description	Average Fiber length	Standard deviation	Coeff. of variation	Average unstretched length	Standard deviation	Coeff. of variation
		(inches)	(inches)	(percent)		(inches)	(percent)
1949 (1)	64's Staple	3.0	.97	32.1	2.9	.35	12.0
1950	64's Staple	3.0	.98	32.7	3.2	.51	16.1
1951 (2)	64's Staple	3.1	.98	31.7	2.9	.47	16.4
1952	64's Staple	2.8	1.02	36.6	2.9	.37	12.7
1949 (1)	64's French	2.7	.90	33.2	2.5	.24	9.5
1950	64's French	2.7	.88	32.2	2.4	.33	13.5
1951 (2)	64's French	2.8	.85	30.6	2.5	.42	16.9
1952	64's French	2.6	.92	35.5	2.5	.42	16.9
1949 (1)	60/62's St.	3.3	1.08	32.7	3.1	.47	15.3
1950	60/62's St.	3.4	1.12	33.4	3.3	.46	13.9
1951 (2)	60/62's St.	3.2	1.18	36.4	3.1	.59	19.0
1952	60/62's St.	3.0	1.19	40.1	3.3	.42	12.9
1949 (1)	58/56's St.	3.5	1.19	34.5	3.6	.53	14.7
1950	58/56's St.	3.7	1.36	37.1	4.0	.38	9.6
1951 (2)	58/56's St.	3.3	1.29	38.9	3.4	.62	18.1
1952	58/56's St.	3.4	1.31	38.9	3.7	.53	14.2
1950 (1)	50's	3.9	1.33	34.0	4.3	.78	18.3
1951 (2)	50's	3.6	1.40	38.8	3.9	.58	14.8
1952	50's	3.8	1.42	37.9	4.2	.73	17.2
1951 (2)	48/46's	4.2	1.36	32.2	3.7	.79	21.2
1952	48/46's	3.9	1.52	39.5	4.5	.48	10.7

(1) Staples were drawn at random by hand from pile of grease wool for years 1949 and 1950.

(2) Staples were drawn from bales by using staple sampling tool for years 1951 and 1952.

A Brief Summary of Points of Interest Drawn From Data Represented in Tables on Pages 96 and 97

The average difference in mean fiber diameter of wool top, from year to year, when comparing all lots of similar description is approximately 0.5 micron. The mean difference within the main sort of similar description range from 0.2 microns for the 64's and finer staple lots to 1.4 microns for the 56/58's staple lots. The year to year discrepancies in the fineness of wool top is more pronounced in the coarser grades, and may be explained in part by the contributions of three different sorters in 4 years or perhaps actual differences in the wool produced.

The year to year average difference in mean fiber length of wool top for all similar lots is approximately 0.13 inch, ranging from 0.6 inch for the lots within the 64's and finer French Combing group to .19 inch for the lots within the 48/46's group.

The year to year difference in average unstretched staple length is very similar to that of wool top.

The average difference of all similar lots being .14 inch, ranging from .02 inch for lots within the 64's and finer French Combing group to .37 inch for the lots within the 48/46's group.

There are not enough cases to compare the average staple lengths obtained by hand selection from a pile of grease wool and average staple length obtained by using the staple sampling tool drawing staples directly from the bale to base definite conclusions. It is indicated, however, that the sampling method using the staple sampling tool and drawing the staples from the bale, which is strictly objective, gives the truest picture of the distribution of staple lengths within a lot.

Scourable Branding Fluid

Scourable sheep branding fluid (formula G) has been used for identification marks on all sheep during 1952, 1953, and 1954. Each sheep was marked with a US brand applied in May of each year and a breeding pen number and letter symbol in October of each year. These brands have favorably scoured out of all grades of wool processed into top by commercial mills. The legibility of these brands have indicated that this scourable branding fluid, which is made in red, black, green, blue and yellow colors, has sufficient durability for many uses.

Additional field tests should be made to compare its durability with that of other branding fluids.

Birth Coat Study

The amount of hair in the fleece and the covering of wool at birth was observed on all lambs born during 1952 and 1953 to determine the relationship between birth coat and life time wool production.

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SEEDING RATES, PRODUCTION AND PALATABILITY OF RESEEDED GRASSES

Several grasses are known to be suitable for artificial seeding of depleted sagebrush-grass ranges of the Upper Snake River Plains. However, little information is available concerning (1) effect of seeding rates upon stand establishment and forage production, (2) relative palatability of seeded species to sheep, and (3) ability of reseeded grasses to withstand grazing and to continue production of palatable forage.

Effects of Rate of Seeding

In a study designed to test effects of seeding rates on stand establishment and forage production of crested wheat, plots were drilled at rates of 2, 4, 8, 12, and 24 pounds per acre. The 2-pound rate was considered light and the 24-pound rate extremely heavy. The seedings were replicated on 3 different areas and in 3 consecutive years. Grazing was not permitted on these plots for the duration of the study.

Effects of seeding rates were most noticeable for the first three years after planting. Stands seeded at 2 and 4 pounds per acre contained less than 1.5 seedlings per square foot and were generally less successful than the stands seeded at 8, 12, and 24 pounds per acre which contained as much as 15.7 plants per foot. These initial differences became progressively less so that at the end of three years after seeding, the lightly seeded stands had increased from less than 1.5 to 2.0 seedlings per square foot and the heavily seeded stands had decreased from 15.7 to 2.2 seedlings per square foot.

After 6 years all stands were producing about the same amount of forage. However, there were slight differences in herbage quality and fullness of drill rows. In general, the plants in the heavy seeded stands produced finer leaves and less flower stalks than did the plants in the light, 2- and 4-pound per acre seedings.

It appears, therefore, that 8 pounds per acre is an adequate rate of seeding on well-prepared seedbeds on the Upper Snake River sagebrush-grass ranges. Heavier seedings will not produce superior stands, except, perhaps, initially, and are therefore wasteful of seed; on the other hand, light seedings of 2 to 4 pounds per acre will produce satisfactory stands only if adequate protection is provided for a number of years. Forage production, therefore, is dependent upon site potential and climatic conditions rather than upon seeding rate.

PALATABILITY OF SEEDED GRASSES

A study has been carried on at the U. S. Sheep Experiment Station since 1950 to provide information concerning the relative palatability of some reseeded grasses and their ability to withstand heavy spring grazing by sheep. Ten grasses are being tested; three,bluebunch, thickspike, and western wheatgrasses, are native to the general area and 7 are introduced species from Eurasia--intermediate, pubescent, Fairway and standard crested, Siberian and tall wheatgrasses and Russian wild rye. The grasses are seeded in replicated plots on a silt loam soil derived from basalt.

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Average annual production over a 4-year period (1951 through 1954) species is shown in the next table. The introduced grasses have produced more forage than all of the native species planted except western wheatgrass, with pubescent wheatgrass producing the most of all. Production of all species has held up well under the current intensities of spring grazing, .39 and .78 a.u.m. per acre. In fact, none of the grasses has shown any decline in production. Either 4 years is too short a period for grazing-induced reductions in production to occur, or the stocking rate used is not heavy enough to cause any reductions. In addition to the spring grazing, all blocks received .70 a.u.m. per acre use in the fall for a respective total animal use of 1.09 and 1.48 a.u.m. per acre.

All of the introduced species, except tall wheatgrass, were grazed significantly heavier than the three native wheatgrasses. The sheep removed significantly more forage from intermediate wheatgrass than from any of the grasses except pubescent wheatgrass. Significantly more forage was removed from pubescent than from any of the other grasses except intermediate and crested wheatgrasses.

These differences in utilization are considered indicative of the relative palatability to sheep of the various grasses because the animals had free access to all species and available forage was seldom a limiting factor. These differences in use also point out one of the hazards of seeding mixtures of grass species which differ widely in palatability. The more preferred grasses are apt to be overgrazed while the less palatable ones are grazed but little.

Average Annual Production and Spring Utilization (1951-1954) by Sheep in Pounds Per Acre, Air Dry, of 10 Grasses, Together with Least Significant Differences for Utilization.

Species	Total Production (lbs./acre, air-dry)	Spring Utilization (lbs./acre, air-dry)
Intermediate wheatgrass	902	180
Pubescent wheatgrass	957	152
Fairway crested wheatgrass	858	107
Standard crested wheatgrass	921	105
Russian wildrye	649	101
Siberian wheatgrass	855	87
Tall wheatgrass	622	52
Western wheatgrass	928	34
Thickspike wheatgrass	510	30
Bluebunch wheatgrass	380	13

LSD (+.01) 68
LSD (+.05) 50